IPETRONIK

M-THERMO2 M-THERMO 8 M-THERMO 16 µ-THERMO 8 Mc-THERMO

M-RTD2

M-SENS2 M-SENS 4 M-SENS 8 M-SENS 8*plus*

M-CNT2 M-FRQ

MultiDAQ

CAN*pressure*

IPEMEASURE
Instrumentation

Engine Compartment Measurement

October 2013

Content

1 Important and general information

1.1 Important information

Please follow these instructions before and during the use and application on any IPETRONIK product!

1.1.1 Safety and Warning instructions

Please follow the instructions **and** information as contained in the user manual!

1. The user can **influence an electronic system by applying the IPETRONIK product**. This might cause risk of personal injury or property damages.

2. The **use and application of the IPETRONIK product is permitted only to qualified professional staff**, as well as, only in appropriate manner and in the designated use.

3. **Before using an IPETRONIK measurement system** in the vehicle it **has to be verified** that **no function of the vehicle, which is relevant for secure operation, might be influenced**:
   - by the installation of the IPETRONIK measurement system in the vehicle,
   - by an potential malfunction of the IPETRONIK system during the test drive.

   In order to avoid possible danger or personal injury and property damages, appropriate actions are to be taken; such actions have to bring the entire system into a secured condition (e.g. by using a system for emergency stop, an emergency operation, monitoring of critical values).

   Please check the following points to avoid errors:

   - Adaption of sensors to components of the electrical system / electronics, brake system, engine and transmission control, chassis, body.
   - Tap of one or several bus systems (CAN, LIN, ETHERNET) including the required electrical connection(s) for data acquisition.
   - Communication with the vehicle's control units (ECUs), especially with such of the brake system and/or of the engine and transmission control (power train control system).
   - Installation of components for remote data transmission (mobiles, GSM/GPRS modems, WiFi and Bluetooth components).

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1.2 General information

1.2.1 About this manual

The manual describes the structure of the IPEmeasue CAN-Bus devices M-THERMO2, M-THERMO 8/16, Mc-THERMO, µ-THERMO 8, M-RTD2, M-SENS2, M-SENS 4/8/8*plus*, M-CNT2, M-FRQ, MultiDAQ and CAN*pressure*, as well as, peripheral devices and accessories.

1.2.2 Version

Handbuch Motorraum-Messtechnik

This manual has the version number 01.09.00, released October 2013

IPEmotion PlugIn IPETRONIK CAN

Contents described in this document relates to the current release version 01.09.

IPEmotion

Contents described in this document relates to the release versions 01.06. to 3.01.00

To run this PlugIn an IPEmotion release ≥ V02.00 has to be installed on your computer.

1.2.3 Legend of used icons

Tip *This icon indicates a useful tip that facilitates the application of the software.*

Information *This icon indicates additional information for a better understanding.*

Attention! *This icon indicates important information to avoid potential error messages.*

1.2.4 Support

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IPETRONIK Verwaltungs-GmbH Baden-Baden is an individually liable society, registry court Mannheim HRB No. 202089

CEOs: Erich Rudolf, Andreas Wocke

Technical support and product information

www.ipetronik.com   E-Mail: support@ipetronik.com

1.2.5 Related documentation

IPEmotion

The documentation IPEmotion.pdf provides you with a description and useful information related to IPEmotion. This documentation is stored in the following standard language dependent directory: C:\Program Files (x86)\IPETRONIK\IPEmotion Vxx.xx.xx\Help.

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- Version number
- Name of the guide
- Page number or section title
- Brief description of the content (e.g. inaccurate instructions, grammatical errors, or information that require clarification)
- Any suggestions for a general documentation improvement

2 General system

2.1 Modular system structure

IPETRONIK Engine Compartment Measurement contains devices of the M2 series (M-THERMO2, M-RTD2, M-SENS2, M-CNT2) and the M series (M-THERMO, M-SENS, M-FRQ, Mc-THERMO), µ-THERMO, as well as, CAN*pressure*. Each device is an independent acquisition system and can be used as a stand-alone devices, as well as, in combination with other devices (also with SIM series devices) in a CAN bus network. The signals (Temperature, Voltage, Current, Pressure) are detected by using corresponding inputs, are digitized as 16 bit sign and output as CAN message on the CAN bus. Each devices has 4 or 8 inputs depending on the design.

CAN*pressure* is a 1-channel pressure sensor with integrated acquisition electronics including a CAN controller. The acquired pressure, as well as, the temperature of the pressure tap are directly output as a CAN signal.

The configuration of all parameters takes place by using IPEmotion and a PC/Notebook with CAN interface (e.g. PCMCIA CAN card or USB-CAN-Interface). IPEmotion, as well as, software applications by different providers can be used for acquiring the signals as CAN message.

An alternative to the Windows PC system is the use of devices or device combinations with an IPETRONIK data logger (M-LOG, S-LOG, FLEETlog, IPElog).

2.2 Connecting the devices via the CAN-Bus

2.2.1 Basics of CAN-Bus

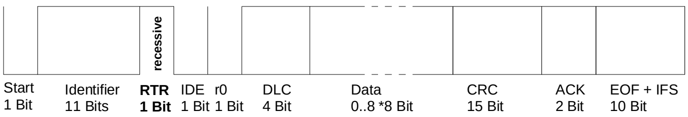
CAN-Standard

The communication of the IPETRONIK SIM and M devices takes place by using the CAN bus according to the CAN 2.0 A (11 Bit Identifier) and CAN 2.0 B (29 Bit Identifier) specification. Each software application, which is able to detect CAN data via a suitable interface, can detect the device data and process. Examples: CANalyzer, INCA, DIAdem, LabVIEW. The device configuration takes place by using the CAN bus and the IPETRONIK configuration software.

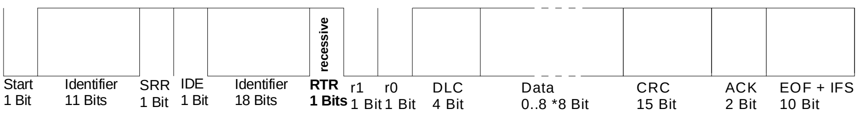
Structure of a CAN message

User data within the CAN message:
Maximum 8 values in the byte format or 4 values (4 channels) in the Word format can be transferred depending on the CAN message.

Remoteframe CAN 2.0A (11 Bit Identifier)



Remoteframe CAN 2.0B (29 Bit Identifier)



CAN 2.0A (11 Bit Identifier)				**CAN 2.0B (29 Bit Identifier)**		
Bits		**Description**		**Bits**		**Description**
1	SOF	Start of Frame		1	SOF	Start of Frame
11	ID	Identifier		11	ID	Identifier
				1	SRR	
1	IDE	Identifier Extension (0)		1	IDE	Identifier Extension (1)
				18	ID	Identifier (extended)
1	RTR	Remote Transmission Request		1	RTR	Remote Transmission Request
				1	r1	
1	r0			1	r0	
4	DLC	Number of following data bytes		4	DLC	Number of following data bytes
64	Data	Data bytes		64	Data	Data bytes
15	CRC	Error Identification Code		15	CRC	Error Identification Code
2	ACK	Acknowledge		2	ACK	Acknowledge
10	EOF	End of Frame		10	EOFS	End of Frame
110		Summe		130		Summe

Word	**Byte**	**Bit (Message layout in the displaying format „Intel Standard“)**							
0	**0**	7	6	5	4	3	2	1	0
	1	15	14	13	12	11	10	9	8
1	**2**	23	22	21	20	19	18	17	16
	3	31	30	29	28	27	26	25	24
2	**4**	39	38	37	36	35	34	33	32
	5	47	46	45	44	43	42	41	40
3	**6**	55	54	53	52	51	50	49	48
	7	63	62	61	60	59	58	57	56

Access to the CAN-Bus, Transferring properties

The CAN bus allows a safe and effective data transfer of the connected devices (non-destructive bitwise arbitration = resource distribution to different devices). The CAN bus is therefore used as a standard communication medium in the automotive area and the industrial automation.

The most important characteristic CAN bus properties are:

- Every bus participant (node) can send, as well as, receive.
- First of all, the node, which wants to send, needs the authorization. All participants become automatically a recipient (There is no abortion of the data sending process > non-destructive collision).
- No stations are addressed but messages.
- Every message is characterized by its name (Identifier).
- The less the identifier, the higher the message priority.
- A message can transport up to 8 * 8 Bit = 64 Bit (8 Byte) user data, whereas each message requires 110 Bit or 130 Bit (Extended ID).
- Depending on the hardware and the bus line length, up to 1 MBit/ s can be transferred.

The following important conclusions result from the properties above:

- The less the bus load, the less the probability of a “Bus access conflict” (you can call this a real-time capable area).
- A high bus load forces stations to loose messages with a high identifier or to send them more slowly. Messages with a high identifier can “get lost”.
- Not sent messages are only registered by the “Recipient node” because data are missing. If no timeout has been defined, the last valid value is generally sent, i.e. a mistakenly constant value.

Transfer rate, Bus line length

The CAN bus supports a max. transfer rate of 1 MBit/s according to Norm ISO 11898-2.

This value is limited in practice by the following points:

- the bus line length
- the branch line length to the CAN stations
- the bus lines quality and the plug contacts
- the bus line design (twisted, single or two-wire bus)
- bus connection structure and
- type and strength of external perturbations

Example	
Data rate on the bus	1 MBit/s = 1 µs/Bit
Data length of a CAN message	130 Bits gesamt
User data in a message	64 Bit = 4 values with 16 Bit resolution each
Time for a CAN message	130 Bit x 1 µs/Bit = 130 µs/message, i.e. 4 values require 130 µs
Calculating the total sampling rate	130 µs match 7.69 kHz
Converted to one channel	4 x 7.69 kHz = 30.76 kHz
Theoretical transfer rate	30 channels with 1 kHz = 30 kHz
Practical experiences	26 channels with1 kHz = 26 kHz
	The value is lower at guaranteed synchrony.)

If CAN messages are not completely used (e.g. only three 16 bit values instead of four per message), less data can be transferred although the sum sampling rate has not yet reached the maximum. This also applies if different sampling rates are defined in one system, because the data division to the CAN messages is not time-optimized (minimum time required).

2.2.2 Ampacity and voltage drop

Besides the fact that the max. bus line length is defined by the desired data transfer rate, the ampacity and the voltage drop in the system have primarily to be checked. This is especially important for systems with a high number of devices and/or long connections lines of the devices (e.g. distributed systems with connection lines of 3 m (9.84 ft) and more between the device groups). Additional actions should be taken accordingly to the situation.

Ampacity

The maximum current via the M-CAN system cables (e.g. 620-560.xxx) is 4 A (heat generation by transition resistances of the plug contacts).

The system capacity and therefore the power consumption can approximately be calculated by using the number of devices (including the sensor supply). A direct power acquisition in the real system provides exact values.

We recommend one or several of the following actions if the limit value is exceeded:

- Increasing the supply voltage of the devices (e.g. 24 V DC power supply or 42 V DC instead of 12 V)
- Centered voltage supply via T connection or as close as possible to the devices with high power requirements (rather than at the beginning or end of the system chain)
- Additional system supply via a T connection at a suitable position

Voltage drop

Even if the limit value for the ampacity is not reached, long lines in an extensive system can cause perturbations in the acquisition process. This mainly applies to devices at the end of the system chain, because the voltage of the last devices does not exceed the input threshold of 9 V (due to a high voltage drop in the system).

We recommend one or several of the actions mentioned above.

The voltage drop can be calculated by using the following formula:

$$U = R \times I$$

$$R = 2 \times R_{Cable\ [\Omega/m]} \times Length_{Cable\ [m]}$$

$$I = P_{Devices\ [W]} / V_{Devices\ [V]}$$

For estimating the voltage drop, a resistance of

50 mΩ/m for the M-CAN cables and
35 mΩ/m for the SIM-CAN cables

can be used including the transition resistances of the plug contacts. Systems, which are in the limit range of the voltage drop, should be controlled in individual cases. To do so, our support will be pleased to assist you.

As the power consumption of a device depends on the supply voltage, it is useful to calculate the voltage drop from the chain end to the feeding point. In this case, a minimum voltage of 9 V is set to the last device and the required excitation is calculated. The calculated value should be generously rounded upwards for guaranteeing a safe operation.

Another fact is the variable internal resistance of the input power supplies (low excitation = lower internal resistance).

In practice, this means: If the net excitation decreases (e.g. because of a weak power supply or a high resistivity with long cables), the devices have to readjust to cover the current power requirements. This causes a higher power consumption, which additionally increases the voltage drop.

2.3 Synchronous data acquisition

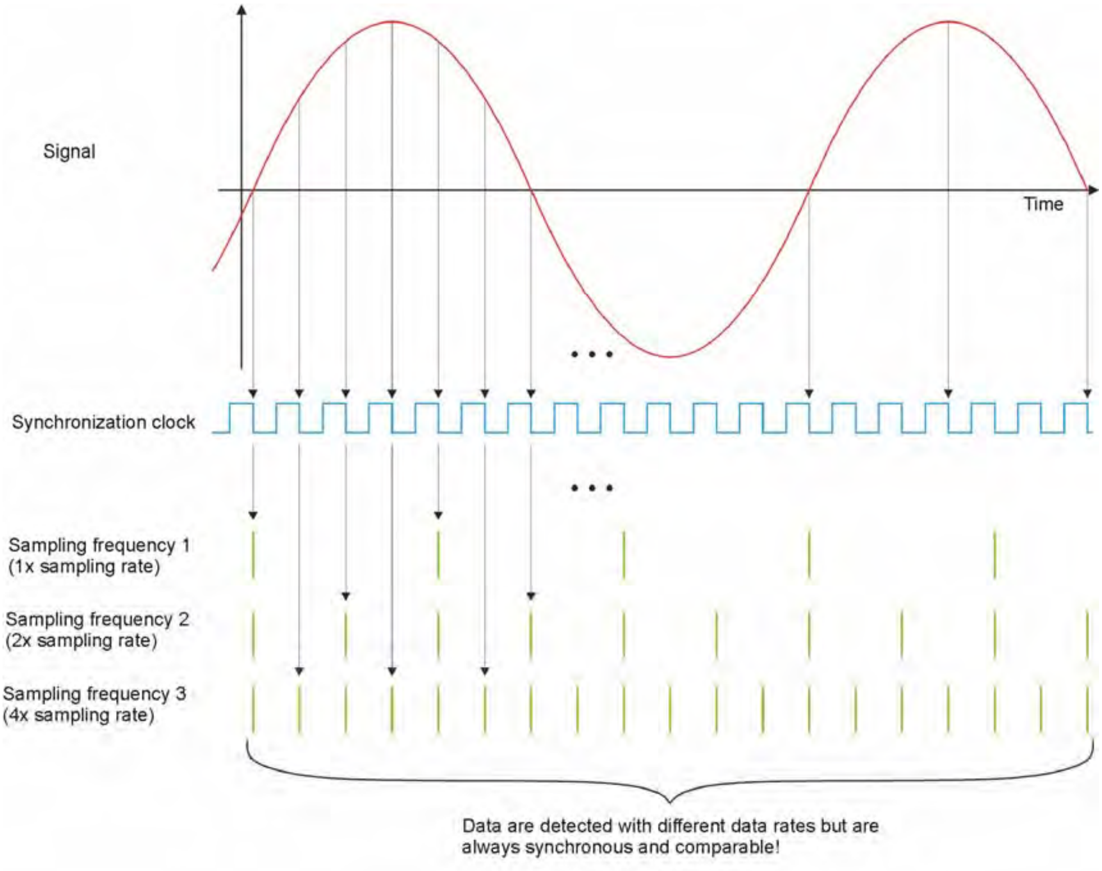
2.3.1 Principle of the synchronous signal acquisition

Every device has an internal clock, which guarantees an equidistant signal acquisition, i.e. the sampling of the momentary values of the continuous signal takes place in identical intervals. This clock synchronizes the A/D conversion of all channels within a device, but not the channels of other devices in the system. The clocks of every device have no reference to each other and differ regarding the clock frequency and phase shifting. Reasons for that are components and manufacturing tolerances, as well as, different environmental conditions.

2.3.2 Master clock as higher system clock

To counteract those disadvantages, a single system clock for all devices (Synchronization clock) is required.

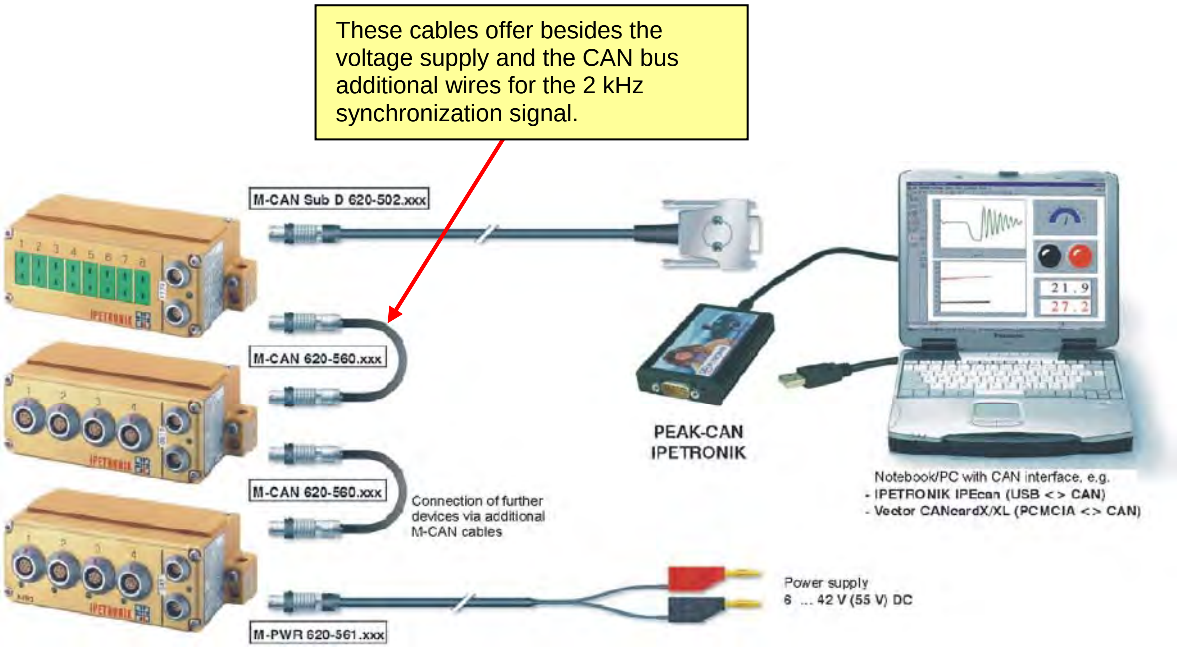
The graphic shows that signals with a high sampling rate, as well as, signals with a low sampling rate are always synchronously detected. This guarantees an simultaneous acquisition of values, which are stored at one date.



2.3.3 Measurement systems without master clock

The non-synchronous acquisition seriously influences the comparability and therefore the plausibility of the acquisition – especially at long-term acquisitions. The time variation of the single clock generators sums with the acquisition time, i.e. the longer the acquisition the higher the deviation. If the frequency deviation and the drift direction of the different clocks is unknown, you cannot assume that all values, which are assigned to a specific value at the time axis, did really exist at that moment.

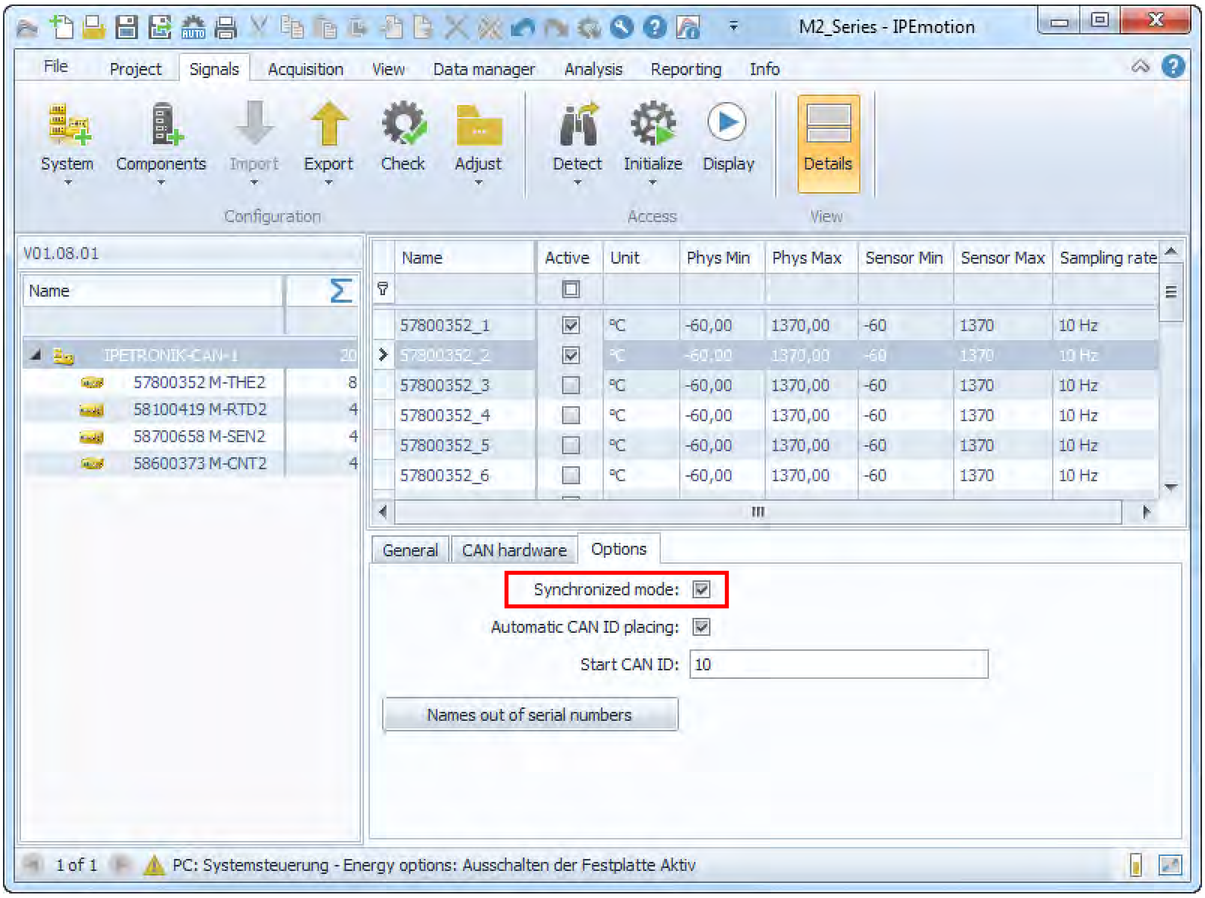
2.3.4 IPETRONIK measurement system with/without synchronization clock



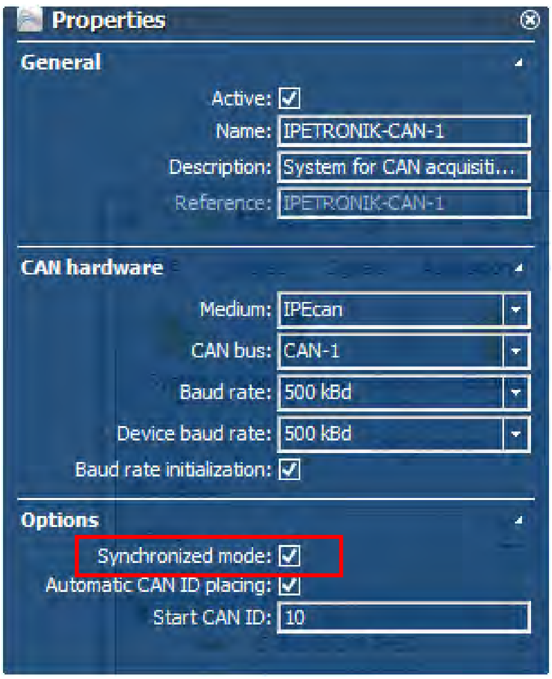
2.3.5 Software settings

The devices in the standard mode (clock = **free**) work with internal clocks. The user can configure if the devices are synchronously or non-synchronously detecting the signals.

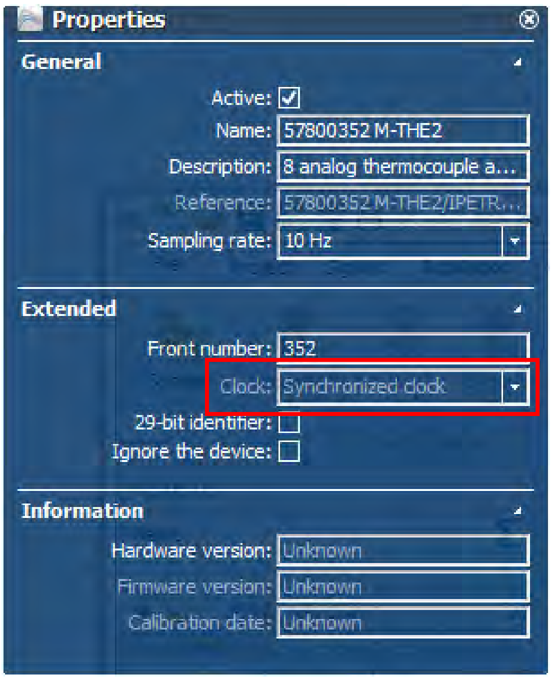
The synchronous data acquisition is activated with the property of the corresponding bus system by using the main navigation point **Signals** within the CAN bus system **IPETRONIK-1 ► Options ► Synchronized mode** (or via the context menu **Properties**). IPEmotion sets one device as the **clock generator** and the remaining devices are set to the **synchronized clock**.



System properties



Device properties



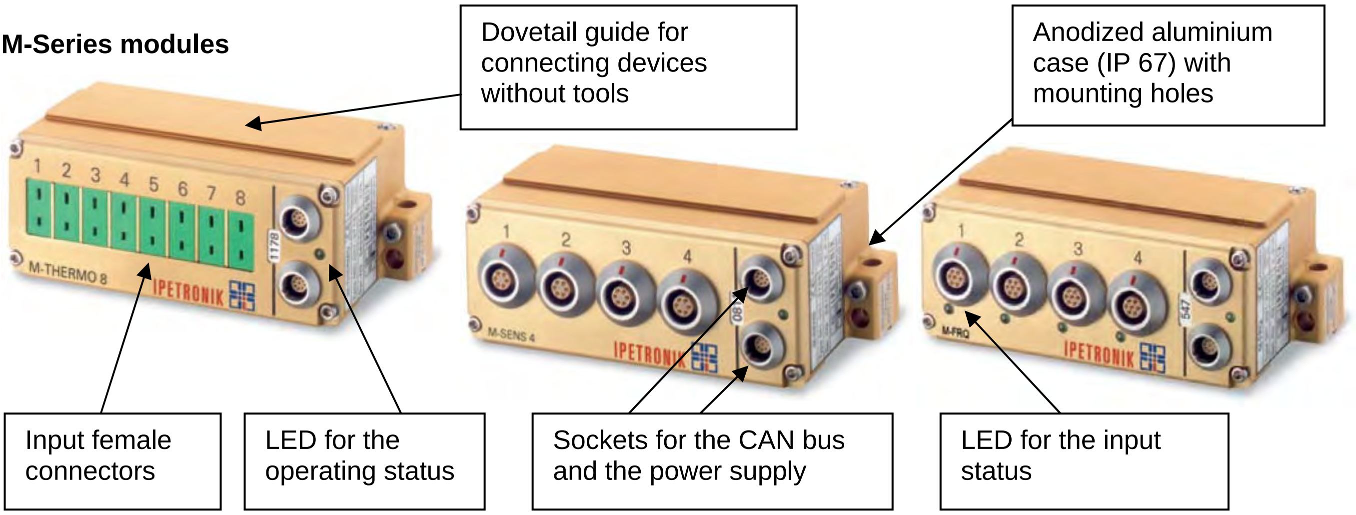
2.4 General device description

2.4.1 Properties and structure

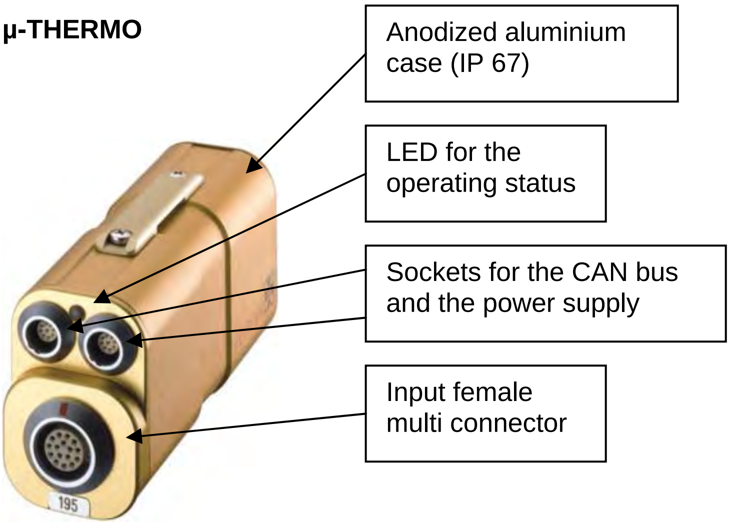
The devices have the following properties in common:

- different channel sampling rates, depending on the device up to 2 kHz
- all channels are completely electrically isolated
- output of the 16 bit data on the CAN bus according to ISO 11898-2
- extended operating temperature range (-40 °C to +125 °C / -40 F to + 257 F)
- very compact case in IP67 protection
- dovetail guide for connecting M series devices without tools

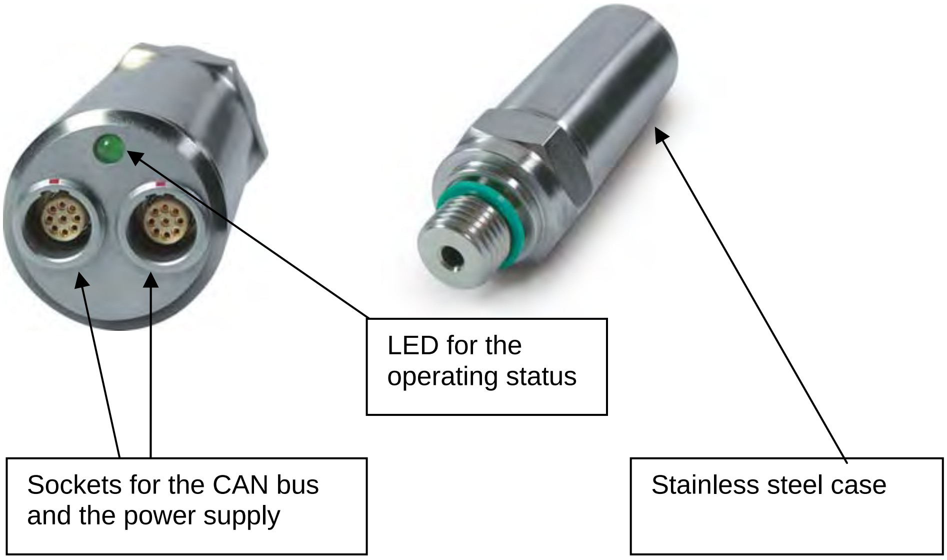
M-Series modules



µ-THERMO



CAN*pressure*



2.4.2 Interpretation of the LED display (flashing codes)

M-THERMO, µ-THERMO , M-SENS, M-FRQ, MultiDAQ, CANpressure

LED display (intervals in seconds)	Mode	Meaning
(continuous)	Operation	Ready for use or data transfer to the configuration (no measuring data transfer)
0.9 0.1 0.9 0.1	System mode	Measurement running! Operation in system with a master device
0.1 0.9 0.1 0.9	Freerunning mode (also synchronized)	Measurement running! Operation in system without a master device
0.25 0.25 0.25 0.25 0.25 0.25 0.25	Error	Error, which requires a restart (PWR OFF/ PWR ON)
0.5 0.5 0.5 0.5	Download kernel	Device ready for firmware download (only at initial update or manufacturer reset)
	Download	Firmware download, flashing frequency corresponds to the transfer of the program lines

The LED color depends on the ambient temperature. Temperatures > 100 °C / 212 °F change the color to yellow.

Mc-THERMO, M-THERMO2

Mc-THERMO und M-THERMO2 verfügen über eine Mehrfarben- Status-LED, dadurch unterscheidet sich die LED-Anzeige von den oben genannten Modulen.

LED display (intervals in seconds)	Mode	Meaning
	Operation	Ready for use or configuration data transfer (no measuring data transfer)
0.1 / 0.9 / 0.1 / 0.9	Freerunning mode (also synchronized)	Measurement running!
	Error	Serious error happend during configuration, measurement initialization or communication
0.5 / 0.5 / 0.5 / 0.5	CAN error	Error in CAN bus communication
	Init error	Error in basic initialization of the module, Current configuration does not match to to the device firmware.

2.4.3 Reverse polarity protection

All M devices have an electronic reverse polarity protection and an additional inrush current limitation.

The reverse polarity protection shields the complete excitation range of the corresponding device and avoids damages due to lines changing PWR+ (red) and PWR GND (black).

The inrush current limitation avoids too high inrush currents, which reduce the durability of switches and relays contacts and avoids the burning of the plug contacts if cables of the power supply are plugged under tension.

2.5 Cables

In order to electrically connect the devices, as well as, the sensors, cables with different lengths and various plug configurations are available:

System cable

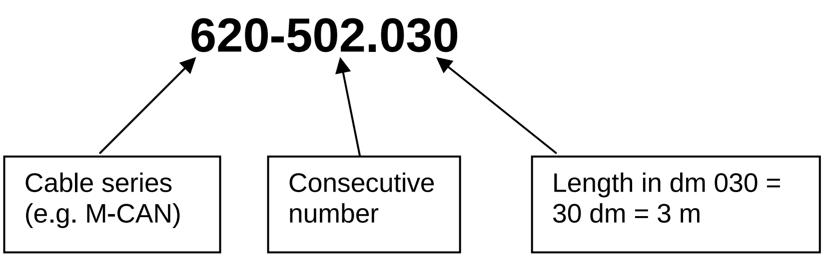
Connect the devices at the CAN bus and contain the data lines (CAN bus and synchronization lines), as well as, the power supply.

I/O cable

Connect the device input with the respective sensor. The cables are open ended with lengths of 3 m, 6 m, and 10 m (9.84/ 19.68/ 32.8 ft).

Cable number

The cable part number identifies the cable type and length, e.g.:

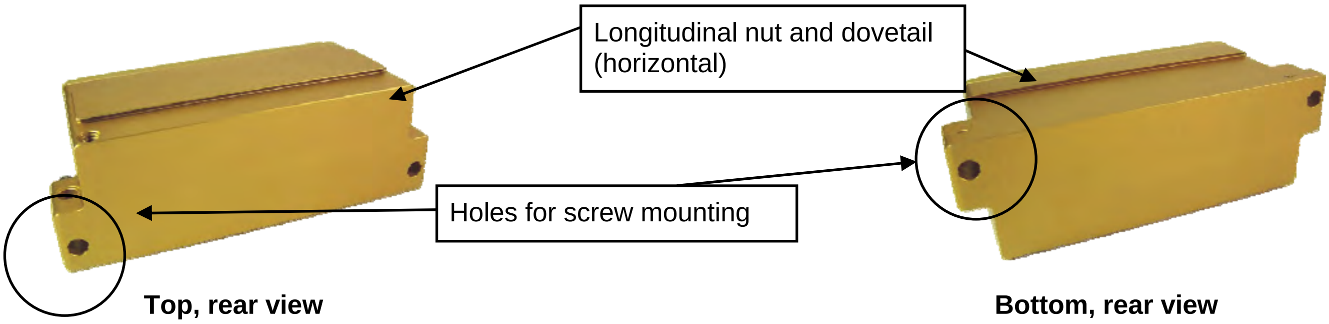


2.6 Mechanical accessories

2.6.1 Differences of the M design

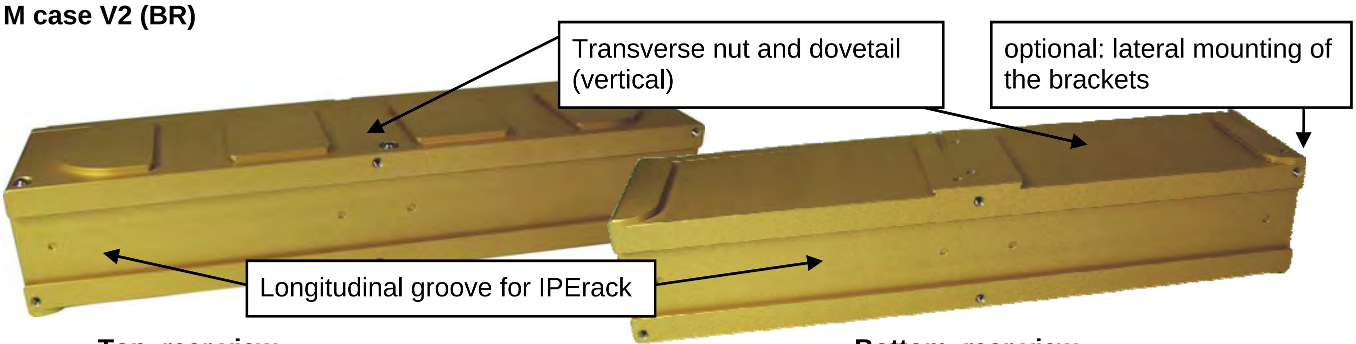
The extension of the M series by the new M-THERMO 16 and M-SENS 8 devices requires new connection mechanics to meet the higher practice demands. The new devices are exclusively available in the 2nd version of the dovetail mechanics (identification BR). The existing devices M-THERMO 8, M-SENS 4 and M-FRQ are available in the 1st version, as well as, in the 2nd version of the connection mechanics. A mechanical compatibility between the devices is guaranteed at using corresponding adapters. If the devices of the same version are connected, only one adapter is required as a bridge between both connecting systems.

M case V1 (horizontal)



Top, rear view **Bottom, rear view**

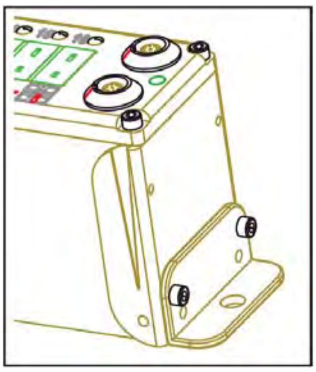
M case V2 (BR)

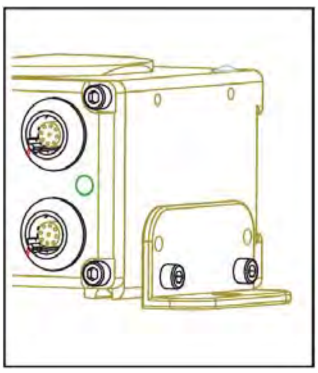


Top, rear view **Bottom, rear view**

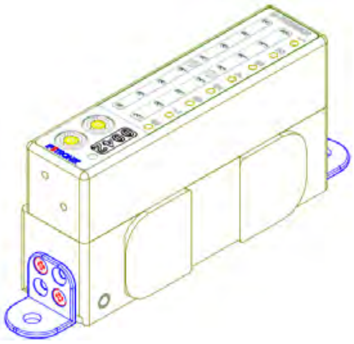
2.6.2 Mounting brackets for M case Version 2 (BR) and M2 case

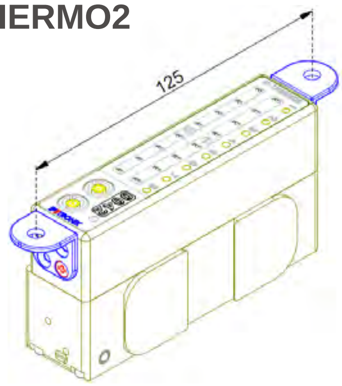
The brackets are used for the screw fastening of the devices with new connection mechanics. Each device requires 2 brackets, which allow different mounting positions.





2.6.3 Mounting brackets for M-THERMO2





MOD-M-TH2-HWI-1

2.6.4 Adapter plates

Dovetail adapter V1/V2 (M case Version 2 long at Version 1)

The existing devices M-THERMO 8, M-SENS 4 and M-FRQ can be connected with devices of the connection mechanics version 2 (only long case design) by using an adapter plate. This plate is slid at the bottom of the long M case (M-THERMO 16, M-SENS 8, M-SENS 8*plus*) and allows the mounting of 2 M devices each in the short case version V1.

MOD-M-ADAPT-100

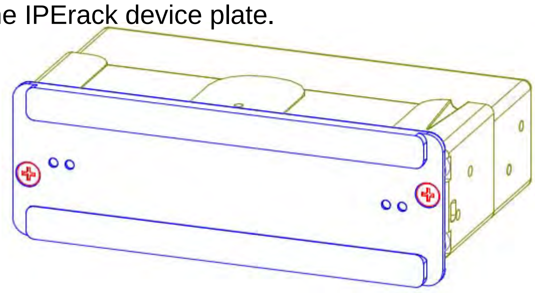
IPErack adapter (M case Version 1 at IPErack)

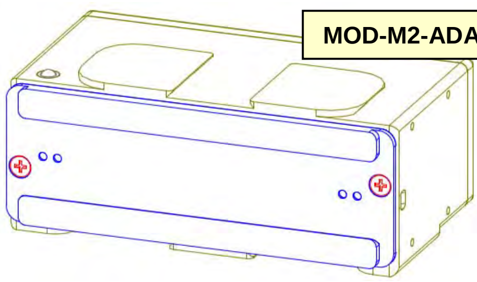
The existing devices M-THERMO 8, M-SENS 4 and M-FRQ can be connected with the quick assembly system IPErack by using a dovetail adapter plate for fixing to the device back. You can therefore fasten the devices without tools to the IPErack device plate.

MOD-M-ADAPT-200

IPErack adapter for M2 cases

The Dovetail adapter plate enables M2 device mounting (THERMO2, RTD2, SENS2, CNT2) without tools to the IPErack device plate.





MOD-M2-ADAPT-1

2.6.5 µ-THERMO snap-in fastener

MOD-SNP-HWI-900

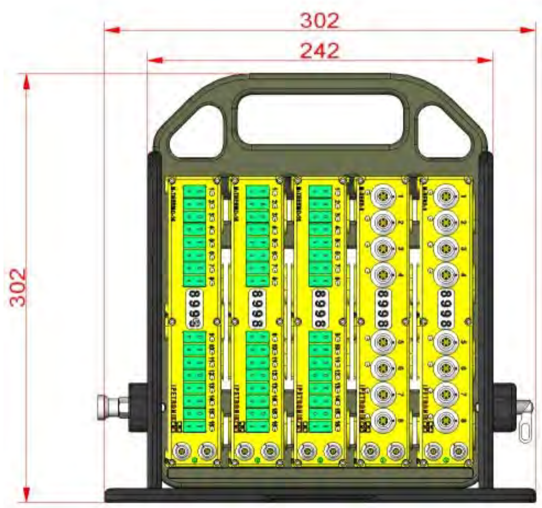
The µ-THERMO snap-in fastener allows the combination of µ-THERMO devices without tools in horizontal, as well as, in vertical order. Each device requires a snap-in fastener.

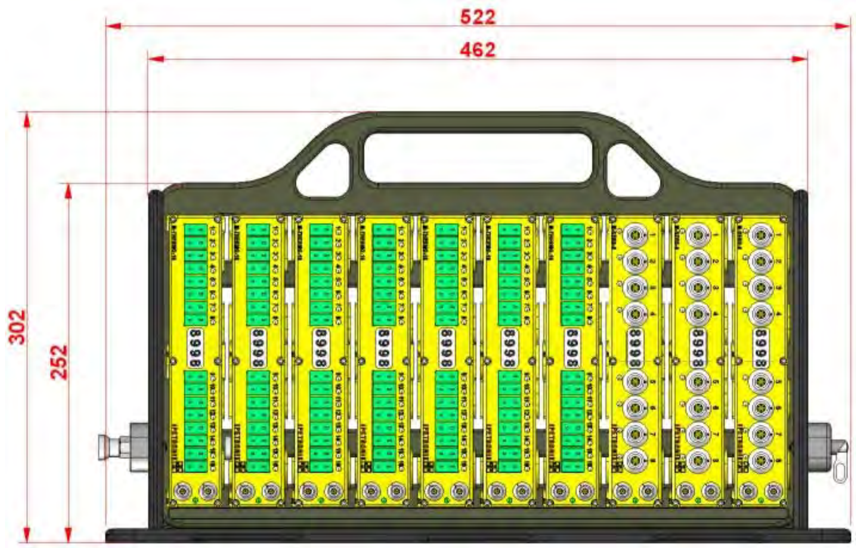
2.6.6 IPErack, quick assembly system for M-Series devieces

- Carrier system containing two exchangeable device plates
- 2 different sizes available
- **per device plate up to:** ( ) = small design
  - 20 (10) devices of the M-THERMO 8, M-SENS 4 or M-FRQ type or
  - 10 (5) devices of the M-THERMO 16 or M-SENS 8 / M-SENS 8*plus* type
- Mixed mountings of the listed devices possible
- Use of devices without a dovetail connection at the back by using mechanical adapter plates
- Safety pins on both sides avoid the accidental extraction of the device plates
- Robust carrier system and device plates out of milled aluminum
- Different transfer and elongated mounting holes for fastening the system at the location.

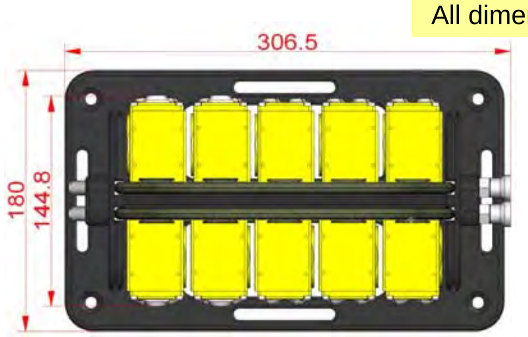
Carrier system		**IPEcrack 20/40**	**IPEcrack 10/20**
Basic plate Length/Width	mm	522 / 180	302/ 180
Side plate Length/Width	mm	237 / 124	237 / 124
Basic plate, Side plate Thickness	mm	10	10
Height carrier system without/with device plates	mm	247 / 302	247 / 302
Weight carrier system without device plates with two device plates	 g g	 2180 5480	 1800 3600
Material		Aluminum, black anodized	
Slide-in for device plates with two safety pins each	Pcs.	2	2
Device plate with carrying handle		**Big plate**	**Small plate**
Width	mm	454	234
Height Top without handle Top with handle	 mm mm	 242 292	 242 292
Thickness (without/with guide)	mm	8 / 10	8 / 10
Mass	g	1650	900
Material		Aluminum, golden brown hard-coated	
Maximum mounting M-THERMO 8, M-SENS 4, M-FRQ and mixed mountings	Pcs.	20 (per plate)	10 (per plate)
Maximum mounting M-THERMO 16, M-SENS 8 / 8*plus* and mixed mountings	Pcs.	10 (per plate)	5 (per plate)

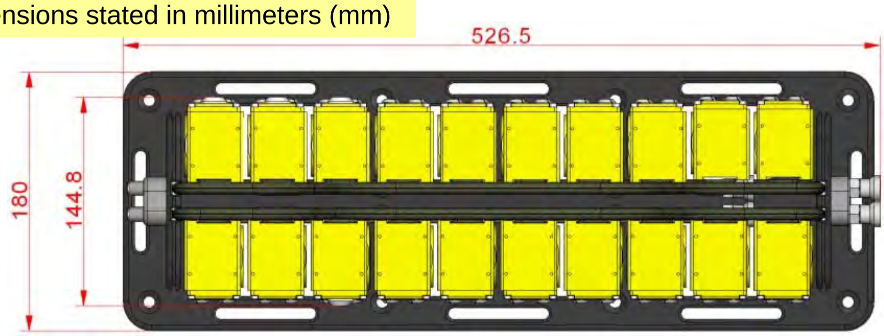
IPErack 10/20 (MOD-IPERACK-003) **IPErack 20/40 (MOD-IPERACK-001)**





All dimensions stated in millimeters (mm)





3 General software description

3.1 Requirements

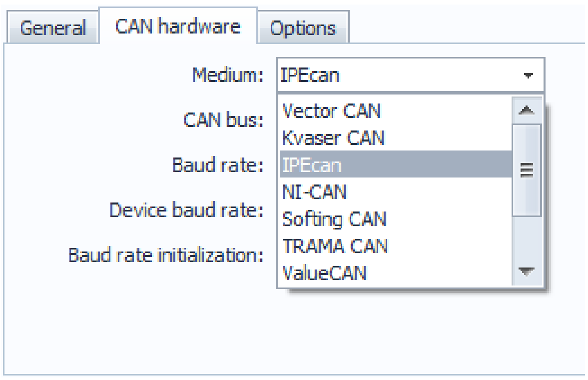
Further requirements besides the hardware:

- **Notebook with CAN interface** (e.g. IPEcan, ...) or
- **PC with CAN interface** (e.g. IPEcan, ...) or
- **M-LOG, S-LOG, FLEETlog or IPElog** (IPETRONIK data logger with real-time operating system)
- The **IPEmotion** software for configuring the device and for acquiring the data via the CAN bus.

The CAN interface must be installed correctly. See the respective manufacturer's manual for further information.

3.2 Supported CAN interfaces

Select the CAN system (e.g. **IPETRONIK-1**) and choose the **CAN hardware** tab for listing the supported CAN interfaces.



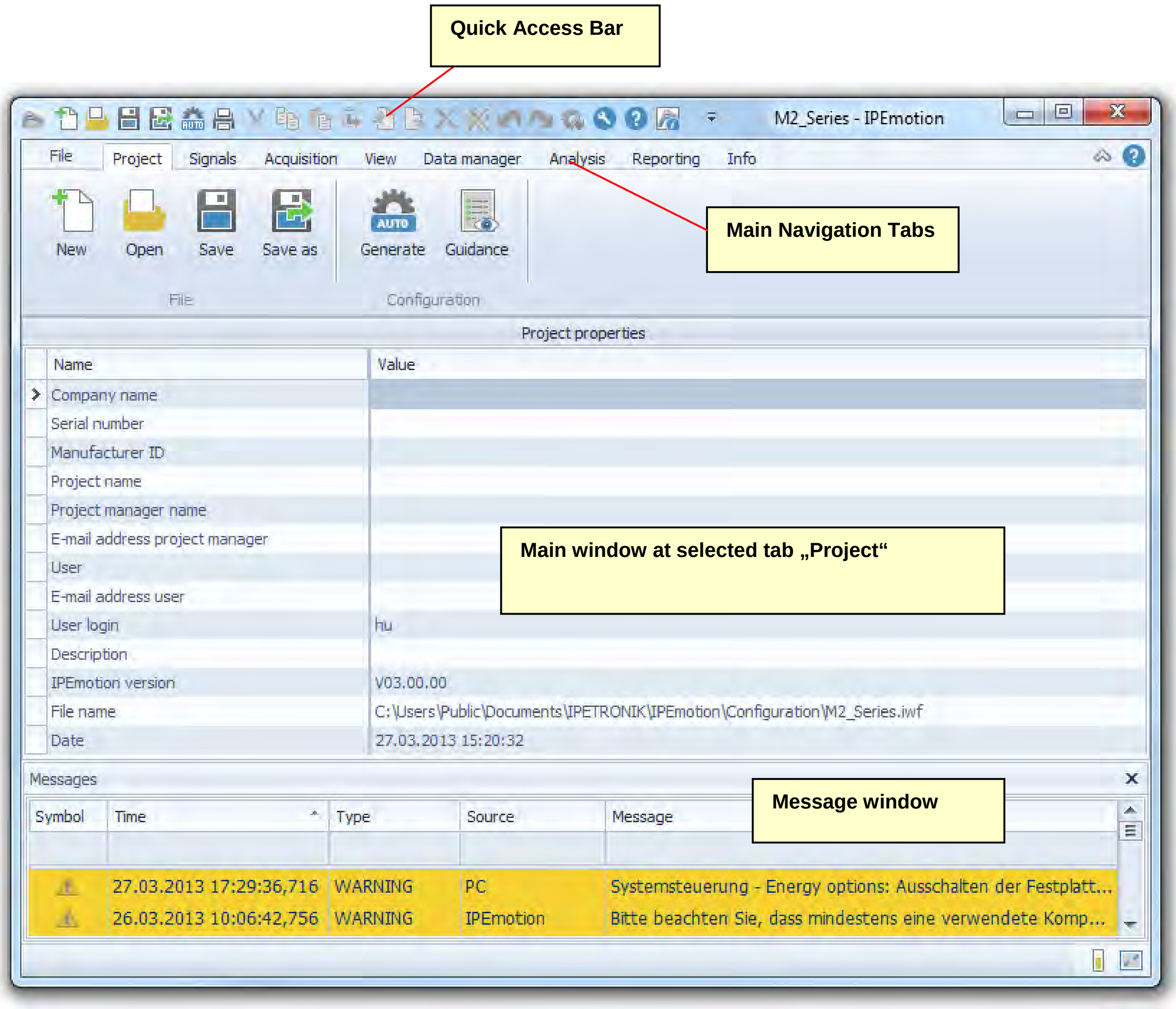
3.3 Configuration with IPEmotion (general)

You can find a detailed description of IPEmotion in the manual, which can be opened in the software as a PDF.

3.3.1 Main dialog

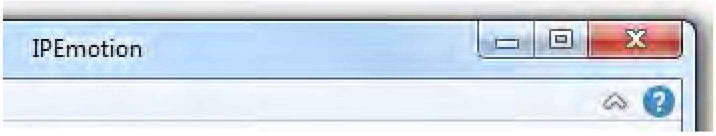
After the start of IPEmotion, the following screen appears.

IPEmotion automatically detects all available hardware connections at starting.
*If you want to reduce the required time, select **Options > PlugIns** for deactivating those interfaces, which are not used.*



3.3.2 The title bar

The title bar contains the quick access bar, the software name, as well as, a tool bar with the following functions:



	**Minimize the Ribbon**	**Ctrl+F1**	Only show tab names on the ribbon
	**Help**	**F1**	Open the documentation IPEmotion.pdf
	**Minimize**		Minimize the application window of IPEmotion
	**Maximize**		Make the application window visible on your desktop and refit the prior size
	**Close**		Close the application of IPEmotion

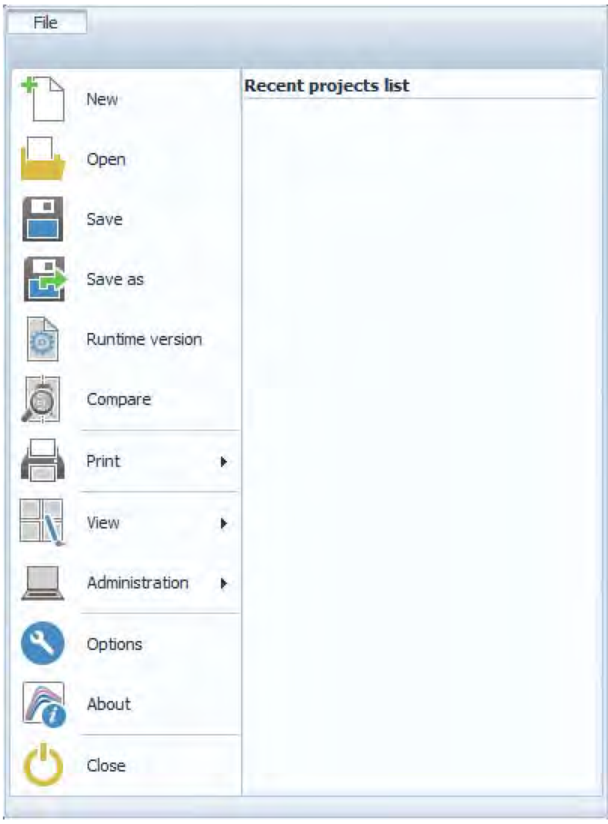
3.3.3 The file menu

Click on the **File** button to open the application menu.

The application menu contains basic functions as: **New**, **Open**, **Save**, **Save As**, **Runtime version, Print** and **Close**, as well as, further properties such as **View**, **Options**, **Support file** and **About**.

The right partial view of the application menu contains a list of the recently used projects.

The **View** function contains the menu points **Message window** and the **Reset** command. Show or hide the message window and reset the displaying configuration to the default parameters.



3.3.4 Using the options

With the Options entry, you have the ability to edit user defined settings. You can define the following options:

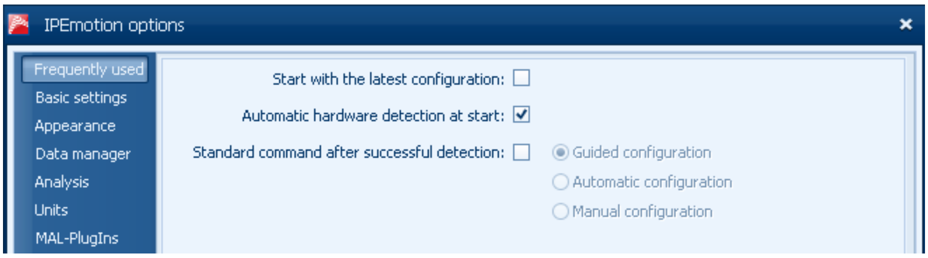
- Frequently used
- Basic settings
- View
- Data manager
- Analysis
- Units
- PlugIns

The following section offers you a detailed overview over the available setting options.

Frequently used

Activate or deactivate **Start with the latest configuration** and define the settings for the **automatic hardware detection.** Activate or deactivate the **automatic hardware detection at start** of IPEmotion and select a possible **standard command after successful detection**:

- Guided configuration
- Automatic configuration or
- Manual configuration

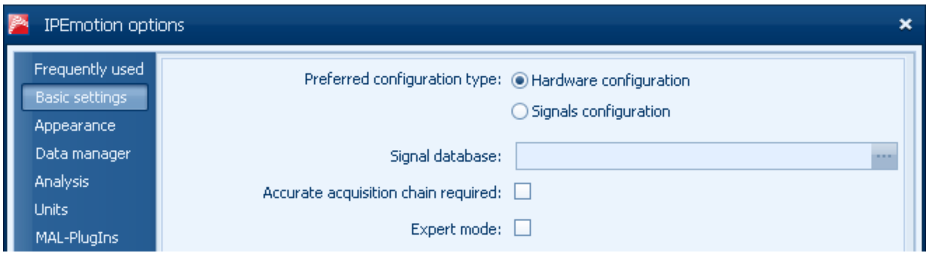


Basic settings

Select a **preferred configuration type**:

- Hardware configuration
- Signals configuration

Activate or deactivate the options: **Accurate acquisition chain required** and **Expert mode**.

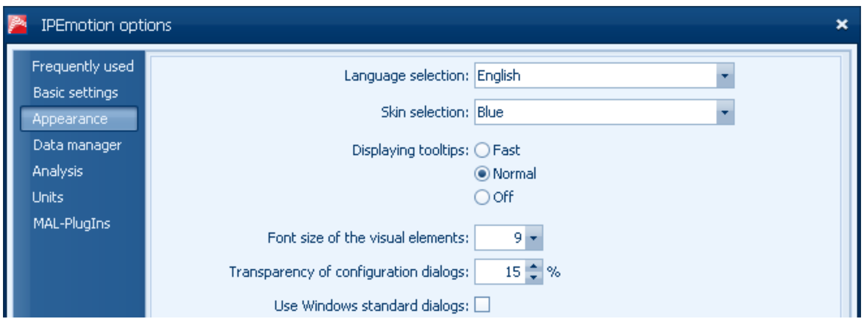


View

Define your **view settings** according the following listed points:

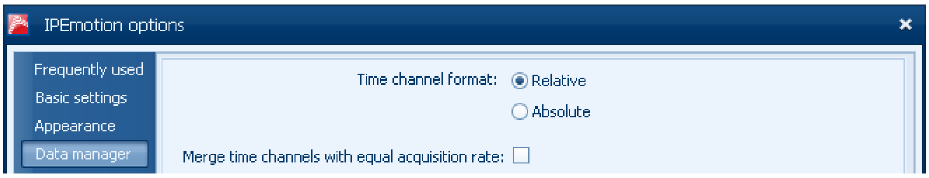
- Language selection
- Skin selection
- Displaying tooltips
- Font size of the visual elements
- Transparency of configuration dialogs (0 – 30 percent),

Activate or deactivate the use of the **Windows standard dialogs** for the file and directory selection. The *Open file* dialog is skin-enabled, i.e. it is shown in the selected user interface type.



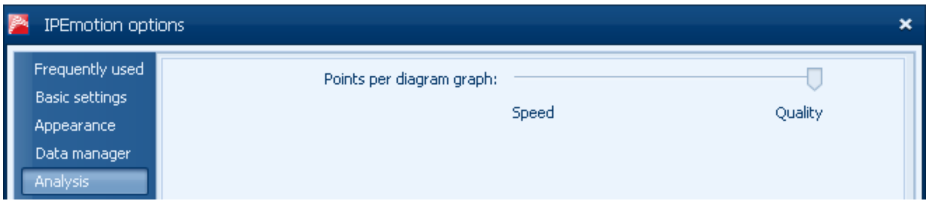
Data manager

Define the **Time channel format** as *Relative* or *Absolute* (This setting is currently not supported for the export into external formats!) and activate or deactivate the option: **Merge time channels with equal acquisition rate**.



Analysis

Select the **points per diagram graph**. Define if all signals are considered in the analysis diagrams at drawing the graph or only the samples. Move the bar accordingly to the preferred speed or quality.



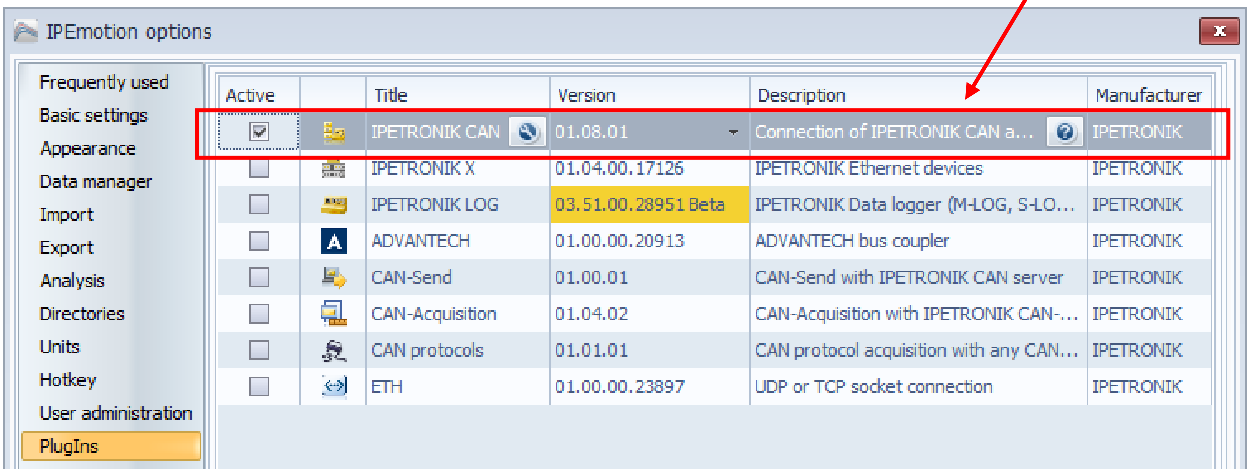
Units

Get an overview according the common physical values and their respective unit and edit them.

PlugIns

Activate or deactivate the **hardware systems** to be used.

This PlugIn is for all IPETRONIK CAN bus devices.

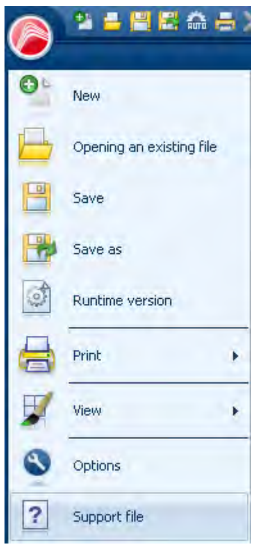


With the **Settings** button, you have the ability to define the **components** (module type and priority, e.g. for the type selection of the Dry configuration) of the respective hardware system and to edit additional **options** settings.

The selection of the hardware components for the configuration by using a signal library is based on the **Priority**. This preselection with a priority assignation of the system components facilitates the device selection and improves the system speed.

The **High** priority defines a preferred use of the corresponding hardware component at configuring with a signal library. The hardware components, which are defined with the **Not used** priority, cannot be selected for an acquisition.

3.3.5 Creating a support file

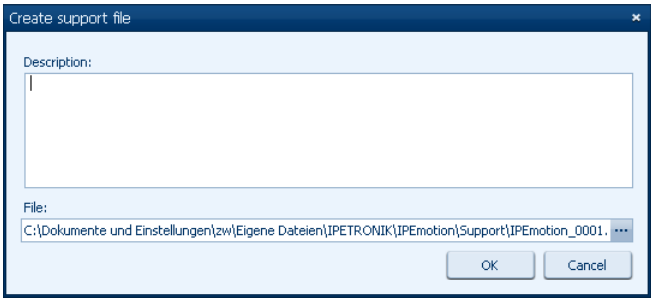


Enter in the appearing **Create support file** screen an error description. Accept the default location for the file. To select another location click on the ... symbol.

After you have specified the location and a user defined file name, click **Save** to return to the **Create support file** screen.

After clicking on **OK** a zip file is generated that contains the error description, as well as, the following information:

- System information (Windows version, computer name, free memory on the local drives, …)
- Current configurations (acquisition, online view, script configurations)
- Trace files (.NET, C++)



If you have any problems while working with IPEmotion, send us this support file at support@ipemotion.com.

3.3.6 The quick access bar

The quick access bar is integrated in the title bar and contains functions that are frequently used. Each of these functions is displayed as an icon.

New	**Ctrl+N**	Create a new configuration
Open	**Ctrl+O**	Open an already existing configuration
Save	**Ctrl+S**	Save the actual configuration
Save as		Save the actual configuration under a new name
Generate		Automatically generating an new configuration with the actual connected devices
Quick print		Directly printing on the standard printer
Cut	**Ctrl+X**	Cut the currently selected elements
Copy	**Ctrl+C**	Copy the selected elements into the clipboard
Paste	**Ctrl+V**	Add elements from the clipboard
Paste behind		Paste elements from the clipboard behind
Copy to file		Copy the currently selected elements to a file
Paste from file		Add elements from a file
Delete		Delete the selected elements
Clean		Delete all subordinate elements
Undo	**Ctrl+Z**	Undo the last step(s)

Redo	**Ctrl+Y**	Redo undone actions
Properties		Open the configuration dialog
Options		Show/edit general IPEmotion options
Help	**F1**	The online help will be opened
About		Show information about IPEmotion (edition, license, options)

3.3.7 The main navigation tabs

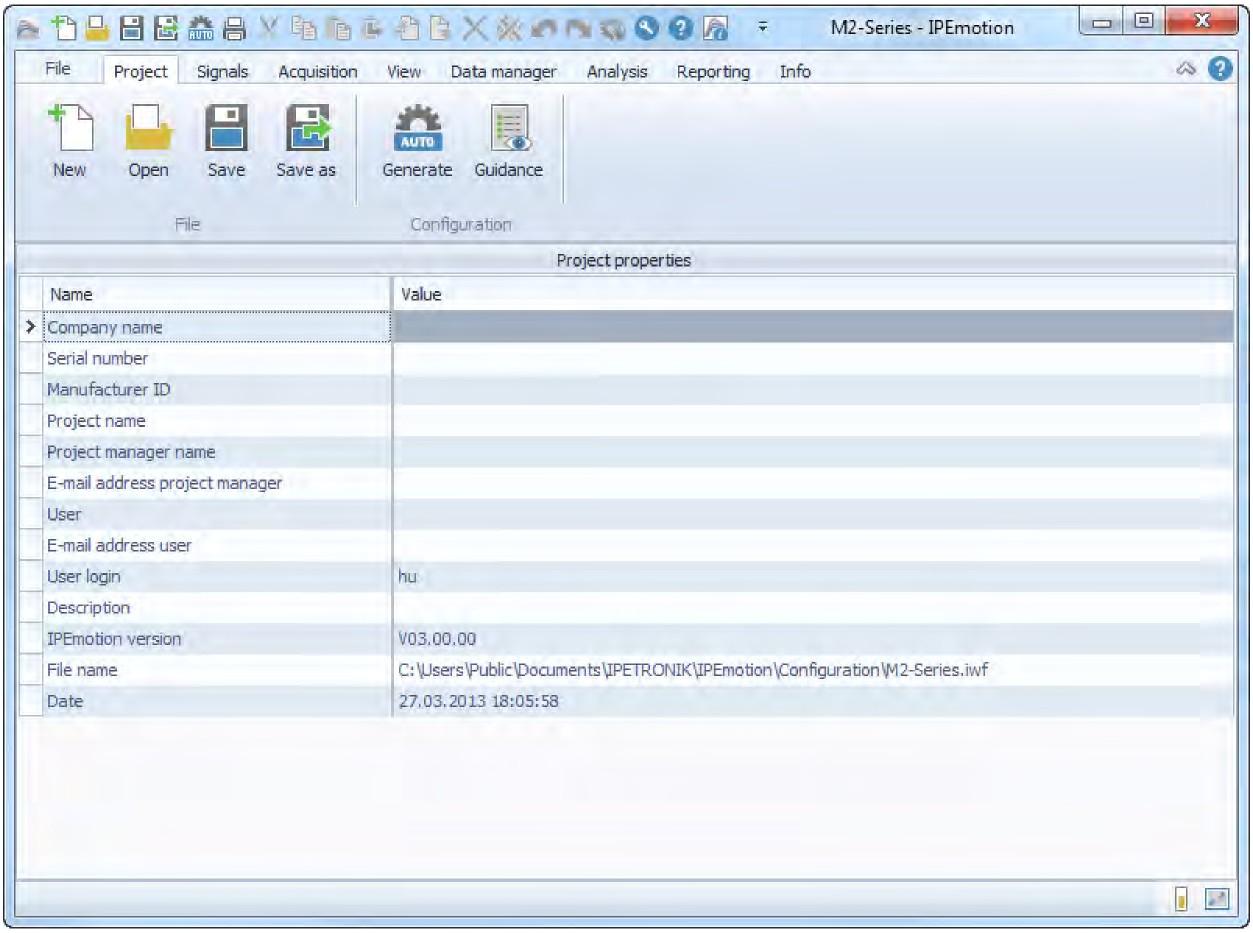
The main navigation tabs allow a quick activation of the different main functions of IPEmotion. A tab displayed in light blue indicates an active function.

IPEmotion is designed to follow the main navigation tabs from left to right. Use this reasonable order like a read thread, which guides you step-by-step to a successful acquisition.

Project	Signals	Acquisition	View	Data manger	Analysis	Reporting	Scripting	Info

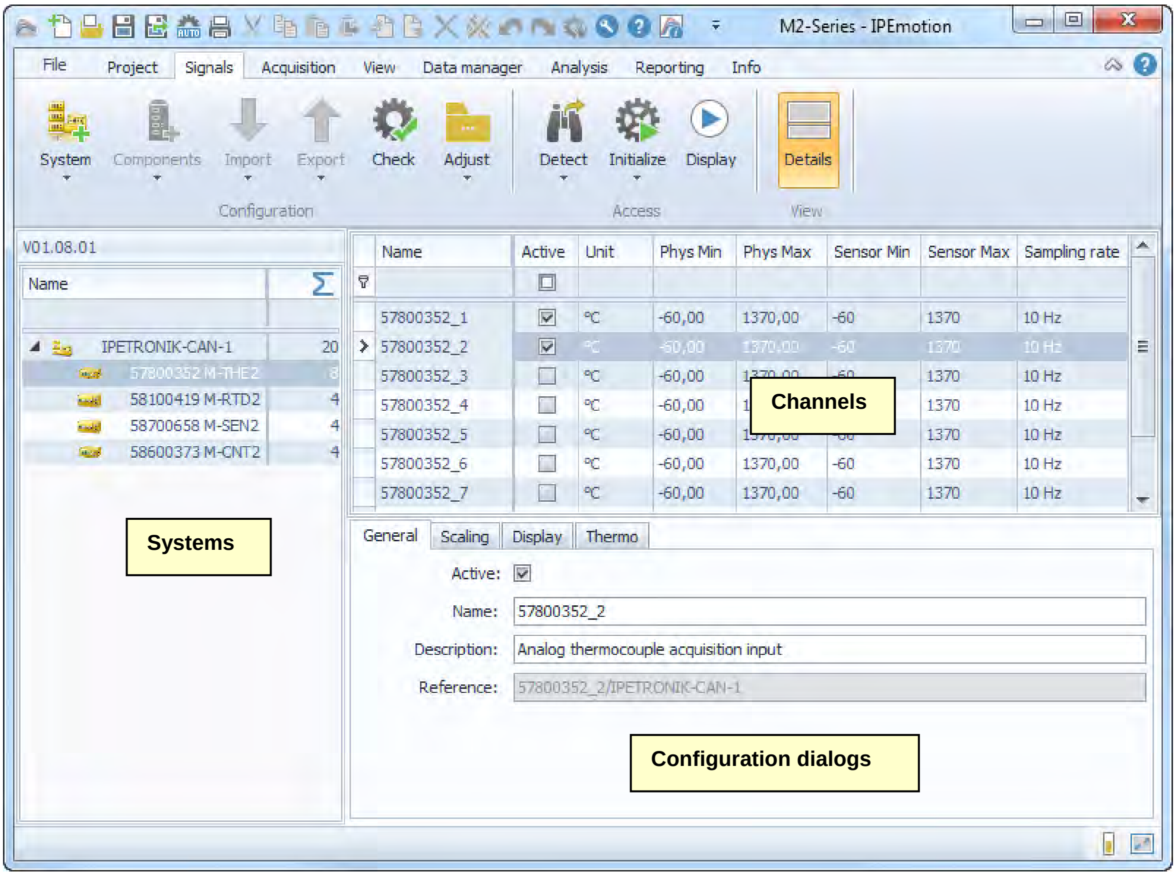
Project	Define your general user defined project data.
Signals	Configure the connected acquisition systems and modules.
Acquisition	Configure the desired storage groups and channels.
View	Take a measurement defined by the connected hardware modules and the set configurations.
Data manager	Manage your stored acquired data in all the supported formats.
Analysis	Visualize your channels with diagrams.
Reporting	Create reports and project documentations.
Scripting	Automate your acquisition sequences.
Info	Get a basic overview and general support.

3.3.8 Project

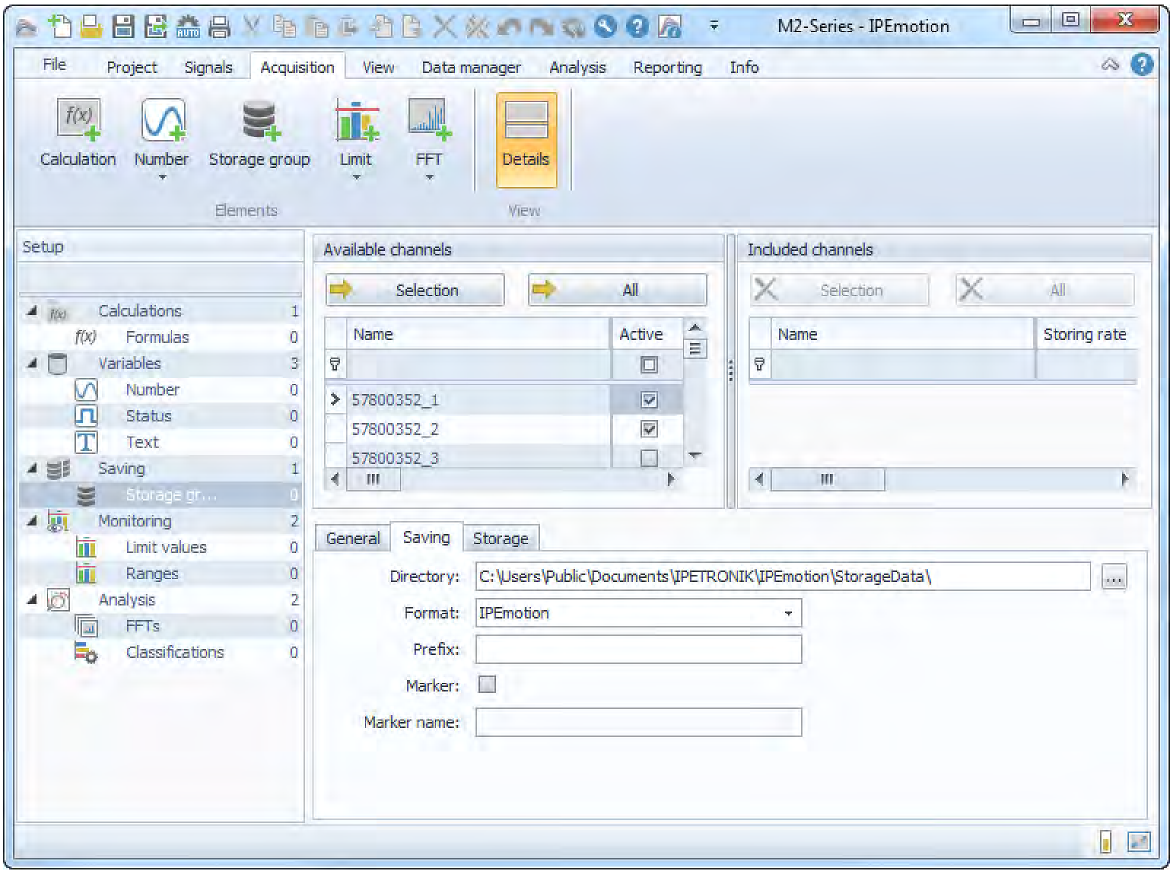


M2-Series - IPEmotion
File
Project
Signals
Acquisition
View
Data manager
Analysis
Reporting
Info
New
Open
Save
Save as
Generate
Guidance
File
Configuration
Project properties
Name
Value
Company name
Serial number
Manufacturer ID
Project name
Project manager name
E-mail address project manager
User
E-mail address user
User login
hu
Description
IPEmotion version
V03.00.00
File name
C:\Users\Public\Documents\IPETRONIK\IPEmotion\Configuration\M2-Series.iwf
Date
27.03.2013 18:05:58

3.3.9 Signals

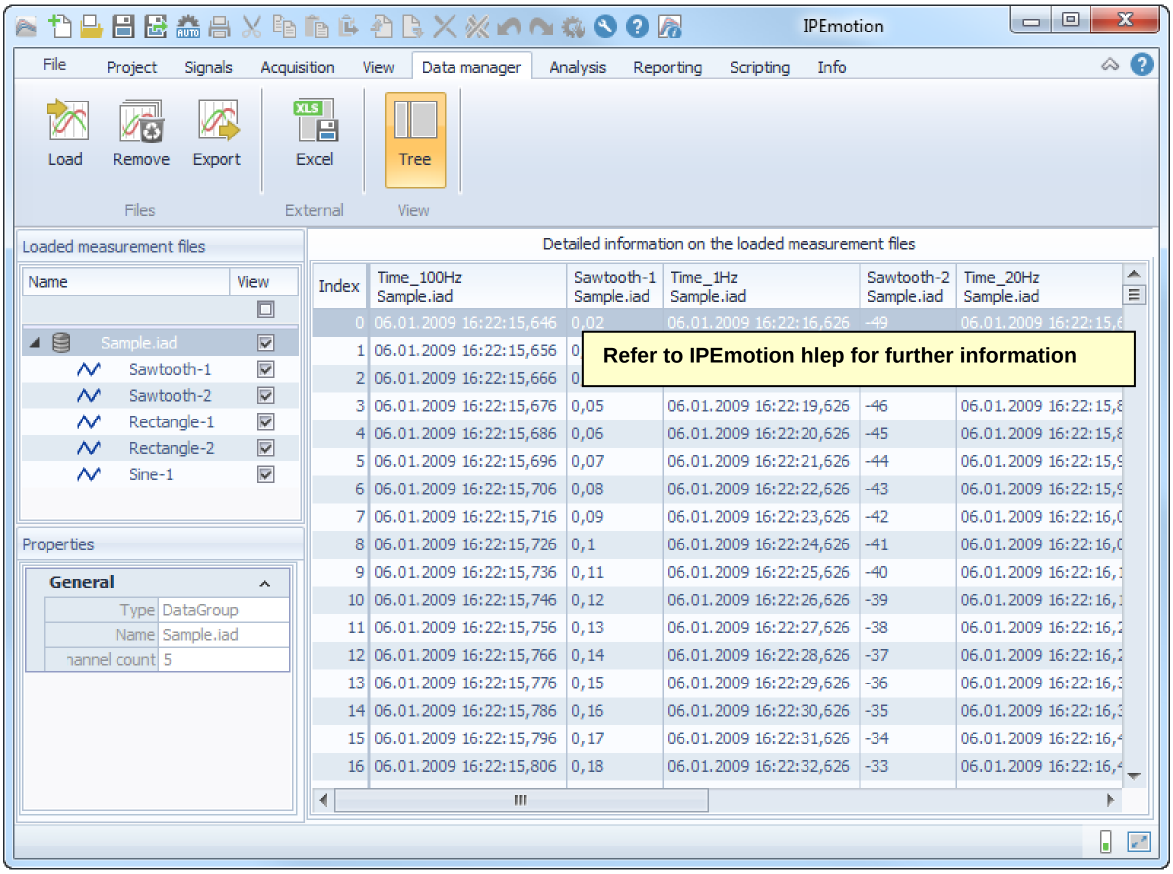


3.3.10 Acquisition

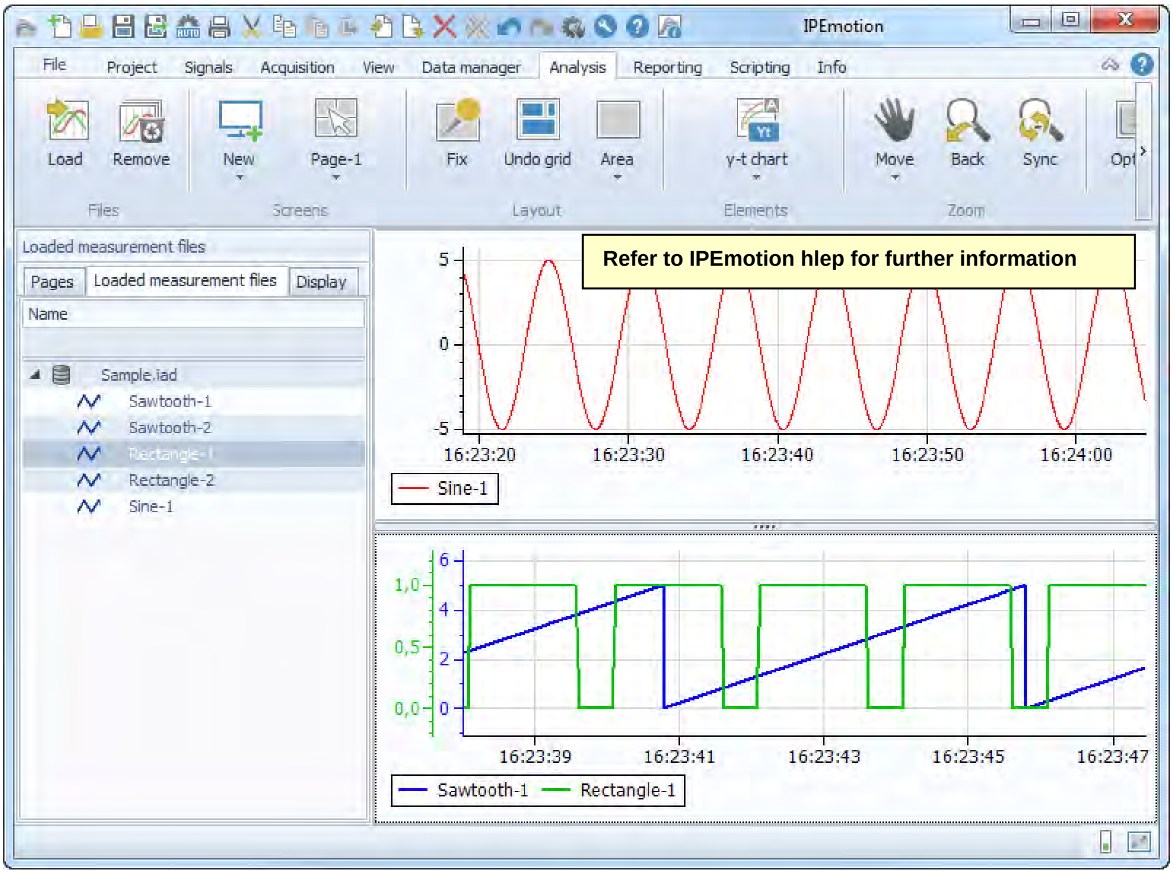


3.3.11 View

3.3.12 Data manager



3.3.13 Analysis



3.3.14 Info

The chapter offers a basic overview of the IPEmotion software. In addition, it shows useful advices and tips and tricks on how to use IPEmotion.

The view Info is divided into the following menu points:

- Welcome
- Release Notes (only in English)
- Red thread
- Tips and tricks
- Keyboard handling
- Documentations
- Contact and support

3.3.15 The first acquisition

Step 1 Connect the device and switch it on

Connect the device(s) to a notebook/PC and to the power supply correctly poled, as described in chapter Modular system structure. Cable types and lengths can vary depending on the application. Switch-on the power supply. The devices will start measuring immediately after switching-on the power supply. The status LED shows the current operating status (see chapter Interpretation of the LED display).

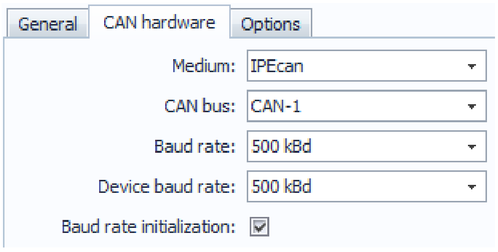
If you use M devices in one system together with SIM devices, please note the following advices:

*Connect the cable for the power supply by using the SIM devices, **not** the M devices. The M-CAN cables allow a lower current load than the SIM-CAN cables.*

Only the M devices allow an operation at a DC supply voltage of 6 V to 42 (55) V. This range is for almost all SIM devices 9 to 36 V.

Step 2 Settings for the hardware interface

With the **Signals** main navigation tab under the CAN bus system **IPETRONIK-1 ► CAN hardware**, you can configure the communication with the measuring devices. Configuring the settings is normally not required because IPEmotion automatically detects the interface and the devices.



*The baud rate of the CAN interface (**Baud rate**) can differ from the baud rate of the devices (**Device baud rate**). When using e.g. devices with 1 MBd (MBit/s), which are currently set to 500 kBd (kBit/s), only change the baud rate of the devices to 1 MBd. The configuration data are then sent with 500 kBd and the devices are finally set to 1 MBd. For automatically adapting the CAN interface baud rate to the device baud rate, the **Baud rate initialization** must be activated.*

If there are devices in the system, which are set to different baud rates, they cannot be addressed. For resetting all devices in a system to one (default) baud rate of 500 kBd, use the M-DEF-100 or M-MOD-DEF-200 plugs.

Step 3 Detecting devices, Reading out settings

IPEmotion automatically detects all available interfaces if they are activated with the **Options ► Frequently used** function. The corresponding PlugIn **IPETRONIK CAN** must be activated (**Options ► PlugIns**).

Select **Detect** or **Automatic generation** for identifying all connected hardware components. If components are already existing in the current system, these settings are overwritten.

Save the current system configuration if required.

Detect reads the connected devices and accepts the settings into the current configuration.

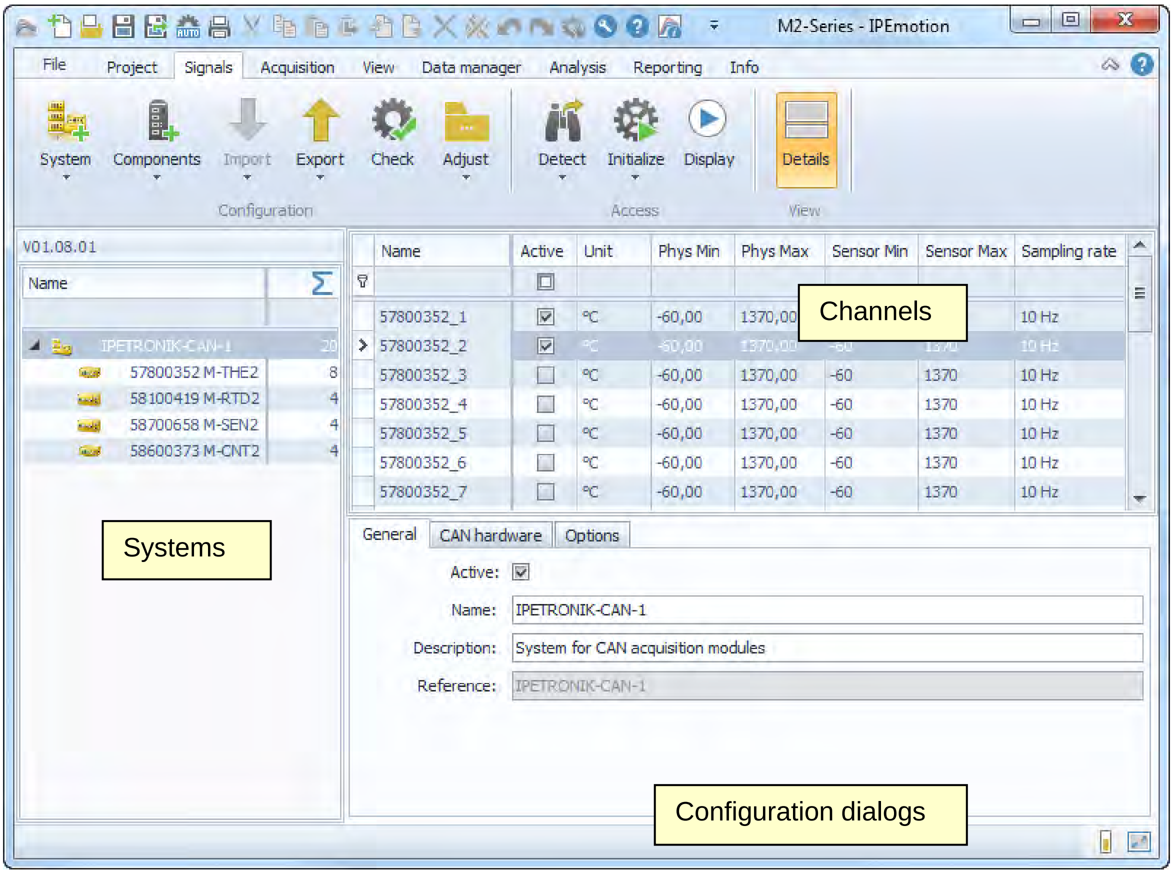
Automatic generation reads the connected devices, accepts the settings into the current configuration, creates a storage group, and creates a graphic view. Devices with default settings (no channel active) are transferred into the storage group with a data rate of 1 Hz and all channels are activated.

Step 4 Configuring the acquisition

CAN-Bus system

Select in the left window (Systems) the corresponding system for listing all channels/signals of the system in the right window (Channels).

Select in the left window (Systems) the corresponding device for listing all channels/signals of the device in the right window (Channels).

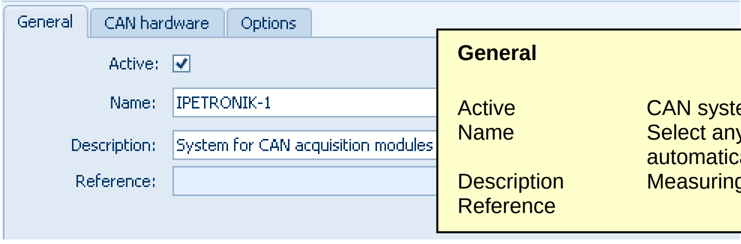


Depending on having selected a system, a device or a channel, different tabs are available in the configuration dialogs for further settings.

Settings of the scaling, as well as, the activating of channels can also be configured directly in the channel table – all other settings can only be set with the configuration dialogs.

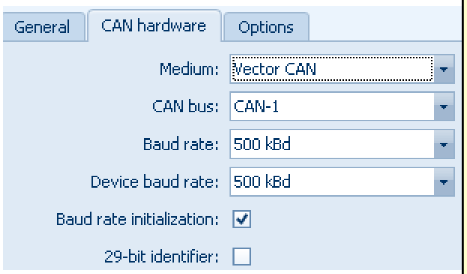
Every channel has configuration parameters, which do exist for all channel and device types (e.g. General, Format, Display) and those, which do always differ because they are channel specific (e.g. Sensor, Filter, Adjust).

The descriptions of the channel specific dialogs are shown in this manual with the respective devices.



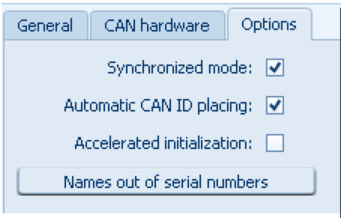
General

Active	CAN system activated for using
Name	Select any name for the system. The name can also be automatically generated with the serial number.
Description	Measuring system description
Reference	



CAN hardware

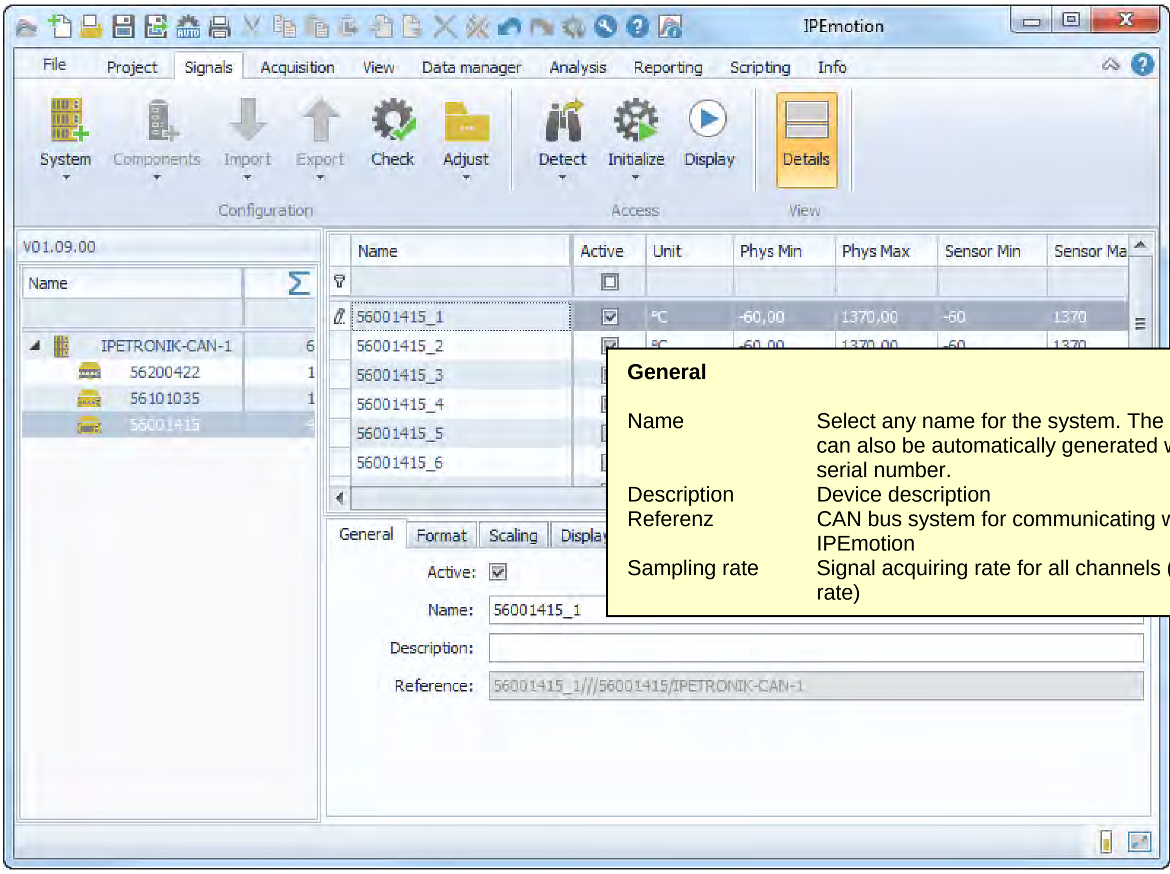
Medium	CAN interface , which connects the devices with the PC/Notebook.
CAN bus	CAN interface bus for communicating (only if the interface has several bus inputs)
Baud rate	Bus data rate of the CAN interface [kBit/s]
Device baud rate	Bus data rate of the devices [kBit/s]
Baud rate initialization	IPEmotion initialized the CAN interface with the set baud rate.
29-bit identifier	Use of 29-bit CAN identifier (Extended ID) for activating the CAN messages.



Options

Synchronized mode	IPEmotion defines a device as clock generator, to which all system devices are synchronized to.
Automatic CAN ID placing	IPEmotion automatically assigns the identifiers of the CAN messages to a set rule.
Accelerated initialization	Only parameters, which have been changed, are reinitialized.
Names out of serial numbers	Automatically generates the channel/signal name out of the serial number of the respective device and the channel number.

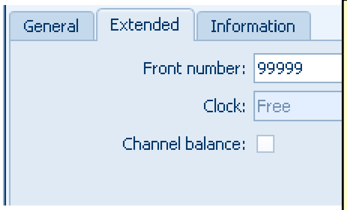
General settings and information about the device



General

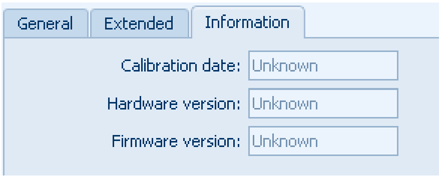
Name	Select any name for the system. The name can also be automatically generated with the serial number.
Description	Device description
Referenz	CAN bus system for communicating with IPEmotion
Sampling rate	Signal acquiring rate for all channels (sampling rate)

Select in the left window (Systems) the corresponding device for listing all channels/signals of the device in the right window (Channels) and showing the tabs for the configuration dialogs.



Extended

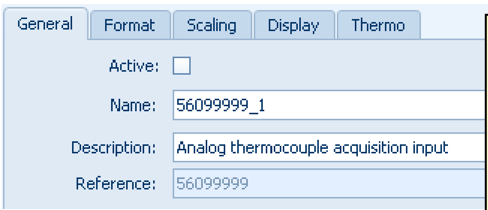
Front number	The part of the serial number, which is imprinted on the device front. If the devices are manually configured (without connected hardware), enter the front number of the device for automatically creating the channel names (if *Names out of serial numbers* is active).
Clock	Type od data detection (Free = with internal hardware clock, synchronized = common hardware clock for all system devices)
Channel balance	Offset calibration of the respective measuring chain of the device channels



Information

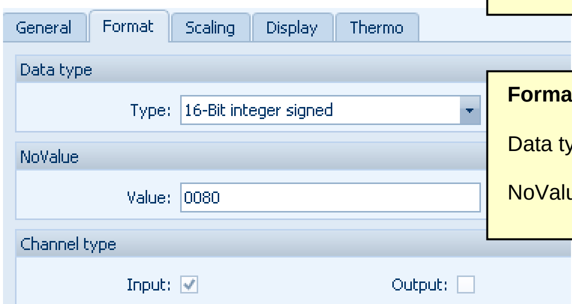
Calibration date	Date of the last device calibration
Hardware version	Hardware version of the device
Firmware version	Firmware version on the device

General configuration dialog



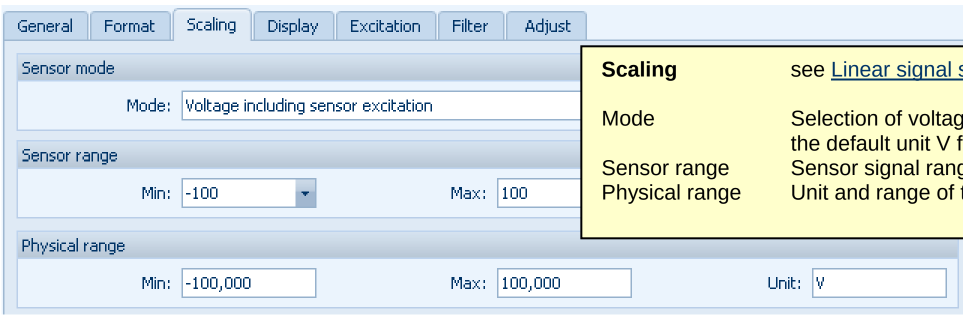
General

Active	Kanal zur Verwendung aktiviert.
Name	Select any name for the system. The name can also be automatically generated with the serial number.
Description	Channel or signal description
Reference	Serial number of the device



Format

Data type	Resolution and sign of the digital value (8 or 16 Bit, signed or unsigned)
NoValue	Value, which is shown, if the current value is invalid



Scaling see Linear signal scaling

Mode	Selection of voltage and current acquisition, sets the default unit V for voltage and A for current
Sensor range	Sensor signal range e.g. +/- 10 V, 0 ... 20 mA
Physical range	Unit and range of the physical size e.g. 0 ... 5 bar

Display

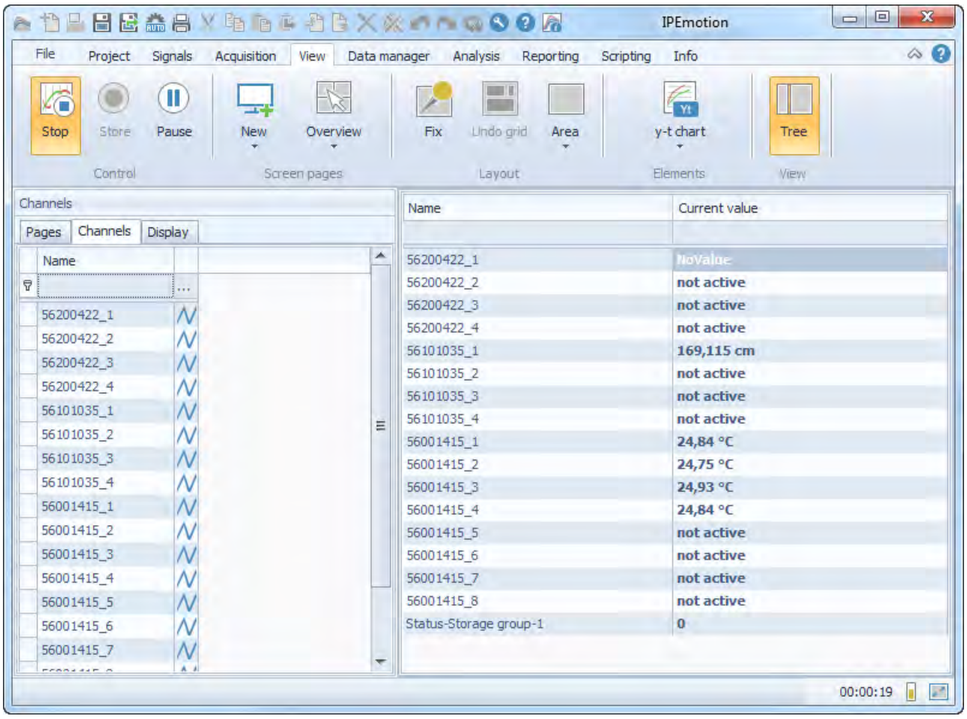
Min / Max	Defines the y-axis range of the graphical display for the *Fix* setting.
Decimal places	Defines the number of decimals of the alphanumerical display, as well as, the current value display in the signal tab

Step 5 Start displaying

Click **Start displaying** within the main navigation tab **Signals** or **View** for starting the acquisition and changing to the data displaying.

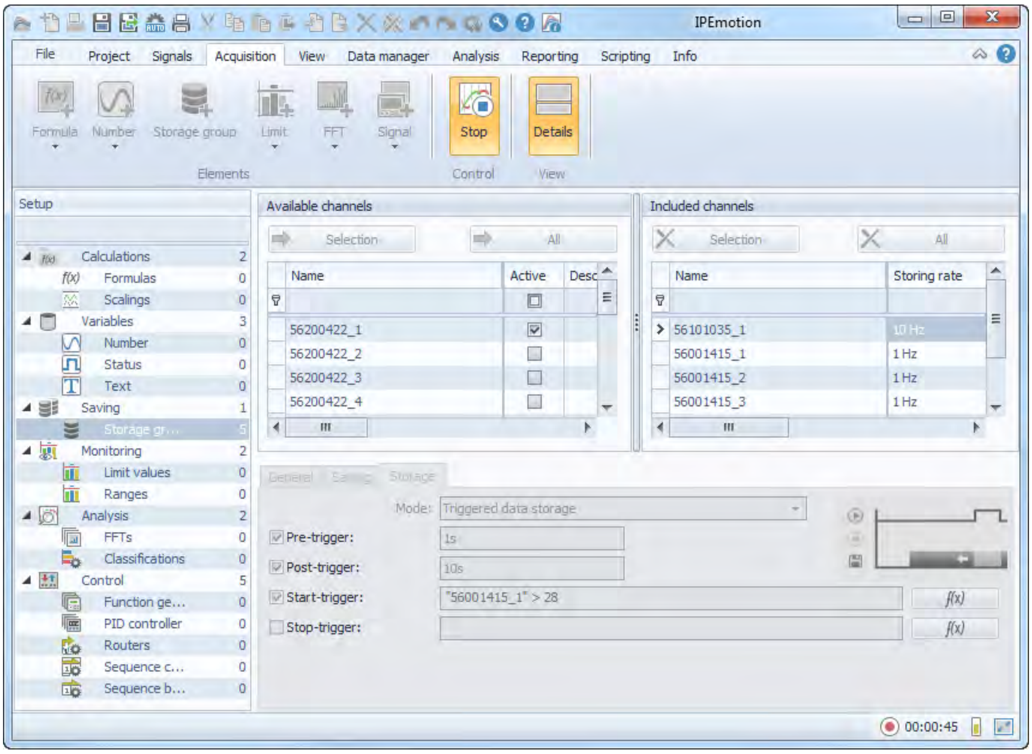
The connected devices are initialized with the current configuration. Finally, all values are shown in the **Current value** column.

If you have already created screen pages for displaying the data (e.g. y-t chart, alphanumerical display, analog pointer…), you can select any screen pages without interrupting the running acquisition.



Step 6 Start storing

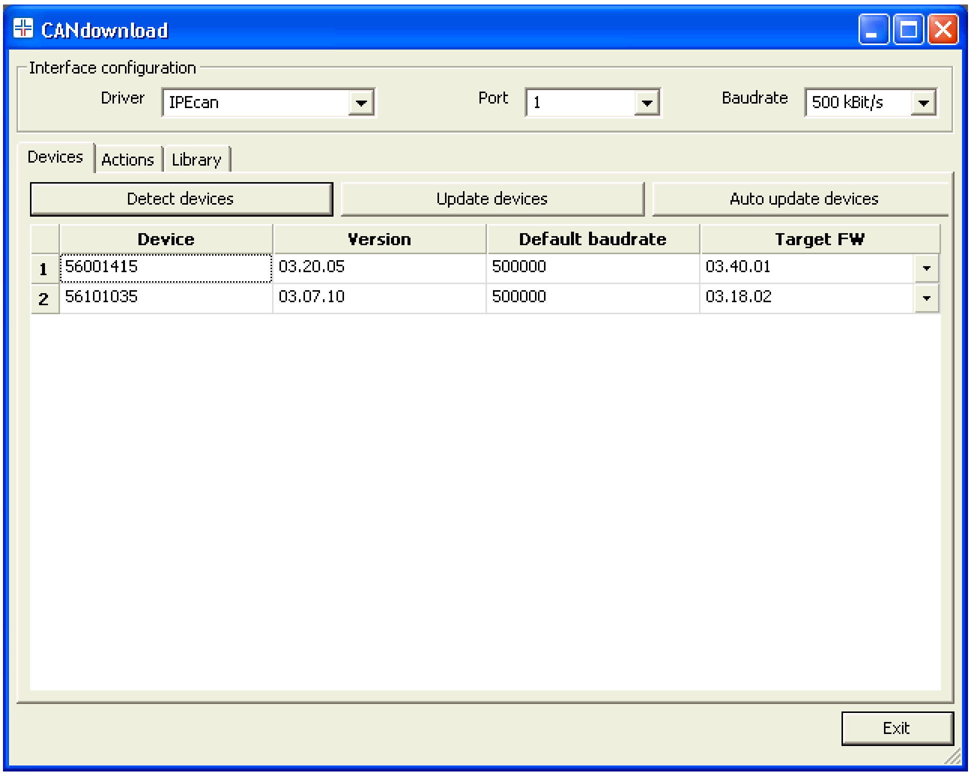
Click **Start storing** within the main navigation tab **Acquisition** or **View** for storing the data on a local medium. First of all, a storage group is required, which contains at least one signal. If required, define individual trigger conditions to start data storage.



3.4 Downloading firmware (CANdownload 2)

The firmware of the IPETRONIK M devices is subject to continuous developments. You can use these developments for your M devices. Therefore, an update of the devices' processor software (Firmware) is required.

3.4.1 User interface



Interface configuration

Define the used *CAN driver*, the corresponding *port* (if several are available), as well as, the desired *baud rate*.

- Driver
- Port
- Baudrate

Devices

Devices – *Detect* and *update* the connected devices, as well as, measuring chains and get information about the *device*, the *version*, the *default baud rate*, and the available *firmware*. Please note that you can only upgrade firmware and not downgrade it!

- Detect devices
- Update devices
- Auto update devices

The **Update devices** function offers the ability to select the desired firmware version.

The **Auto update devices** function contains both functions and has **no** possibility to manually select the firmware.

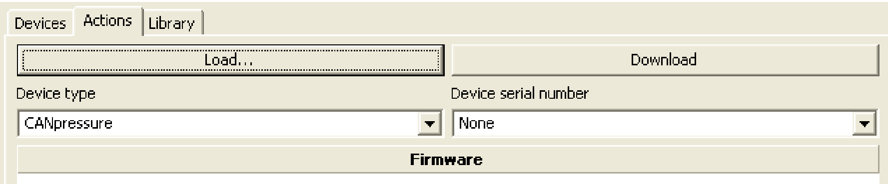
Actions

Load the download file (*.cal) generated by IPETRONIK, which you received via e-mail from your IPETRONIK support and *download* it to a specific device. In addition, define a specific *device type* and the corresponding *serial number*. You can create and run an individual download process.

- Load
- Download

Please note that this process can only be run at connecting the device as a single device!

Entering the serial number is mandatory if the firmware contains a configuration file (Config.).



Library

Get an overview about the current CANdownload firmware versions and download the latest firmware versions from a user defined directory into the CANdownload library.

- Check for updates

To update a library, proceed as follows:

- Select the desired IPETRONIK FTP **connection string** or a user defined directory.
- Click on the **Check for updates** button. A progress bar shows the running updating process.

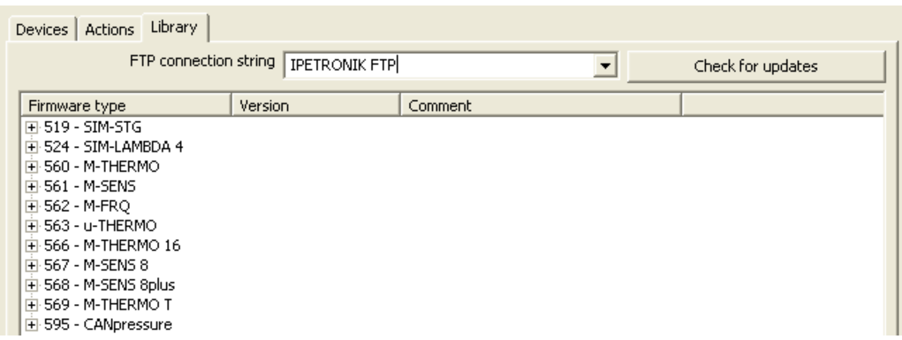
The current CANdownload 2 version supports the following structures for creating user defined directories:

- ftp://
- file:///
- file:////

CANdownload is based on the definition that only one directory for all update files and the fw.lst file is required. You have the ability to use a user defined directory with own released firmware versions (see chapter Creating an user defined library).

Please note the following need of using own libraries with firmware versions:

The file with the name fw.lst must be stored in the corresponding update folder. The file name may not be changed!



3.4.2 Creating a user defined library

CANdownload 2 allows for defining an own firmware library and creating an user defined directory with all firmware files. If the access onto the corresponding directory is realized via the normal file access, the storage of a text file in the user defined directory is mandatory! This file contains a list of the directory content and is named fw.lst.

The library file name is structured as follows:

“device type”_”download type”_”version”.cdf

The current CANdownload 2 version supports the following download types:

- DLK: Download kernel
- RDLK: RAM Download kernel
- ADLK: Application Download kernel
- PIC: PIC-Firmware
- FPGA: FPGA-Firmware
- APPL: Firmware
- TBL: Table
- CFG: Config
- SPC1: Input Processor 1
- SPC2: Input Processor 2
- SPC3: Input Processor 3
- SPC4: Input Processor 4
- FDLK: FPGA-Download kernel
- PDLK: PIC-Download kernel
- CDLK: Channel Processor Download kernel
- CHN: Channel Prozessor Firmware

3.4.3 Manual configuration

To update the firmware of devices, proceed as follows:

- Connect the devices with the power supply.
- Click **Detect devices**. The appearing list contains the current firmware versions of each device. The *Target FW* column shows a required update.
- Select the latest firmware version.
- Click **Update devices** to start the updating process. This process can take some minutes.

3.4.4 Automatic configuration

To automatically update the firmware of devices, proceed as follows:

- Connect the devices with the power supply.
- Click **Auto update devices** to start the updating process. All connected devices are automatically detected and all firmware versions, which do not correspond to the latest one, are updated. This process can take some minutes.

Please note

Due to continuous developments of the hardware and software components, incompatibilities can occur. Please contact our support department at +49 (0) 7221/ 9922-333 or mail to support@ipetronik.com.

Make sure that the voltage supply will not be interrupted during the download process.

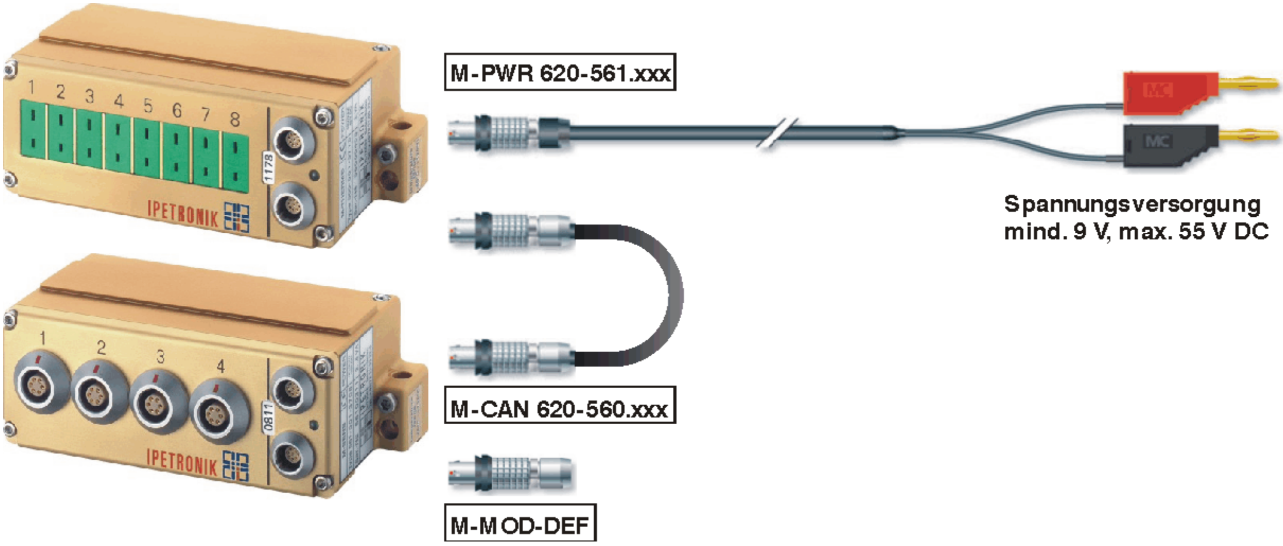
Do not run further programs under Windows during the download process.

If several devices in one system are updated, they must be set to one baud rate (see "Configure HW…"). In case of doubt, the setting of the respective devices should be checked because a break of the download process could cause a loss of being able to address all devices.

After (every) successful firmware download, the device must be restarted (Power off/ Power on) for guaranteeing a correct operating. This is especially required when transferring several files to one device.

3.5 Resetting devices to default values (M-MOD-DEF)

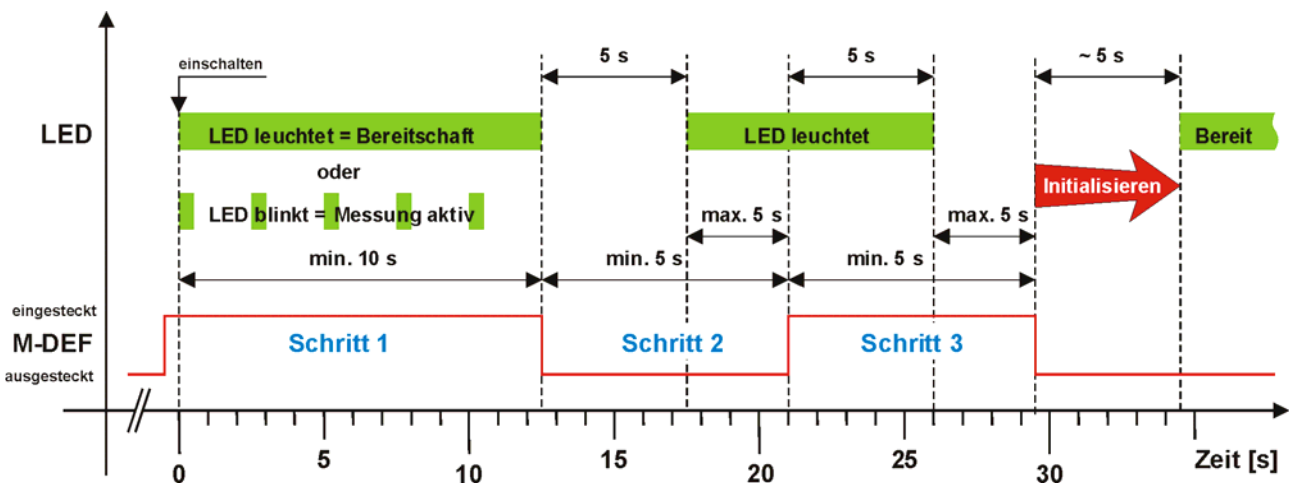
IPETRONIK offers the ability to simultaneously reset single or several devices to the respective default values by using the default plugs (M-MOD-DEF-100, M-MOD-DEF-200). This is recommended if devices are set to different and unknown baud rates for the data transfer. Or if a single device, which has not been configured correctly, must be reset.



Preparation

- Connect the devices and the M-MOD-DEF plug as shown above.
- Switch-on the power supply.

How to proceed (M-MOD-DEF-100)



The proceeding is divided into three steps.

- The default plug must be connected during booting.
- *Please note the chronology for a successful reinitialization.*

Brief instruction for proceeding:

Valid for firmware with release date > 12/2006

1. Connect M-MOD-DEF-100 plug
2. Switch-on voltage supply → LED lights up
3. Wait 10 s, disconnect plug → LED off
4. As soon as the LED relights, connect M-DEF again
5. As soon as the LED turns off, disconnect M-DEF again
6. Running initialization, LED lights up after approx. 5 s
7. Default initialization completed

If all steps were successful, the default initialization starts.

After the successful default initialization (approx. 5 s), the device(s) is in the standby mode because no channels are active (LED is permanently on).

How to proceed (M-MOD-DEF-200)

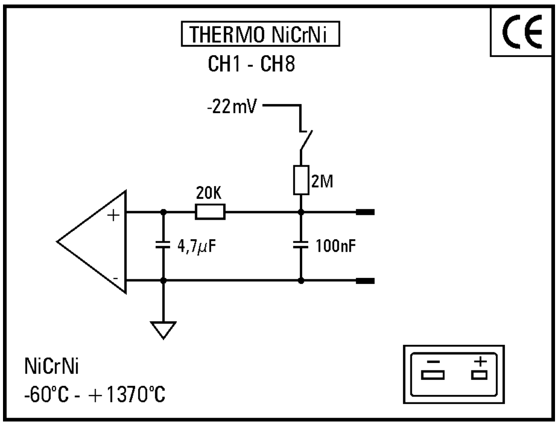
1. Connect M-MOD-DEF-200 plug
2. Switch-on voltage supply
3. Device LED flashes, Plug LED flashes
4. Device LED is permanently on after a while, Plug LED flashes
5. The initialization is complete as soon as the plug LED turns off
6. Switch-off voltage supply and disconnect M-MOD-DEF-200

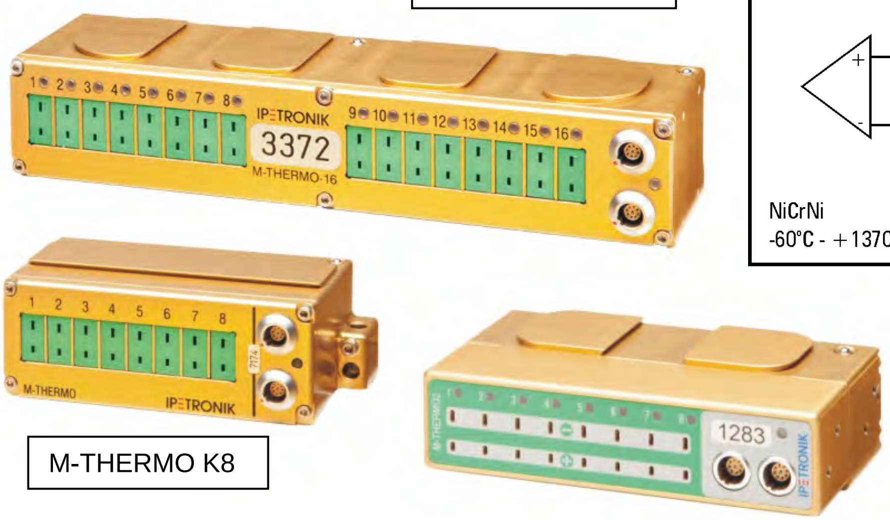
4 M-THERMO2, M-THERMO 8, M-THERMO 16

4.1 Temperature acqusition with thermocouples

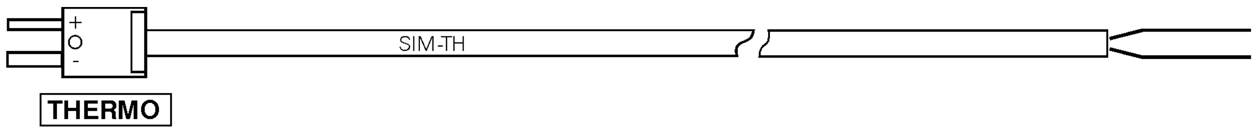
M-THERMO offers temperature acquisitions (range –60 °C to +1370 °C / -76 °F to 2498 °F) with thermo-couples of K type as 8 channel, as well as, 16 channel version with miniature thermo sockets.
PT resistors at the aluminum tub of the sockets (M-THERMO 8/16) respective at each input connector (M-THERMO2) calculate the thermo-electric voltage and provide the cold junction compensation. For providing exact results within the entire acquisition range, the non-linear characteristic of the thermocouple is adjusted by an internal linearization table. An optional impressed current through the sensor allows a sensor break detection, which is activated within the software.

Due to the different thermo-electric voltages and the non-linear characteristic, a thermocouple with an input of the K type is not recommended for other thermocouples..





4.2 Input cable 600-888.xxx



Anschlußbelegung / Connection

SUB-MIN-Stecker, 2-pol. (grün)
SUB-MIN-male, 2-pol. (green)

Pin-Nr. Pin-№	Bezeichnung Designation	Litze-Nr. / Farbe Wire-№ / Colour
+	NiCr	grün / green
-	Ni	weiß / white

All input cables are also available in different lengths, as well as, with further plug configurations.

4.3 Specific input settings

The break detection and the averaging are activated within the configuration dialog **Thermo**.

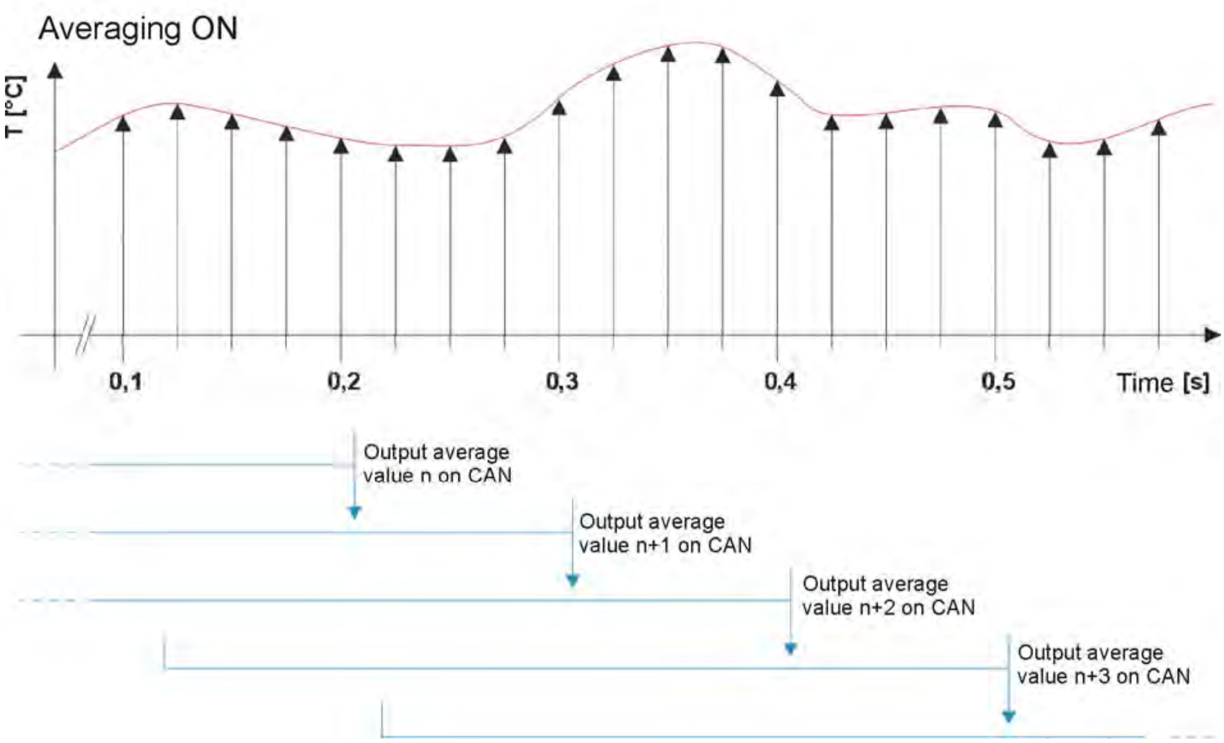
4.3.1 Break detection

A low current flows through the thermocouple at activated sensor break detection, which has no influence on the measuring result. If this flow is interrupted (sensor break), the result is –Fullscale. A distinction between –Fullscale by sensor break and real –Fullscale value is not possible. But the value –Fullscale is rarely possible. The break detection can therefore be used for identifying errors.

4.3.2 Averaging

In order to reduce the noise level in a signal, M-THERMO offers the ability to activate the averaging. The average value of the signals is calculated online over a period of the last 4 CAN sampling periods.

With a sampling rate of 10 Hz, the floating average is calculated online out of the 4 previous CAN outputs and sent with the defined updating rate (here 10 Hz).



4.3.3 Status LED at the input

Only 16 channel thermocouples and the M-THERMO2 have a status LED at every input.
The respective LED indicates the following two states:

1. Identification of the respective channel during the configuration. The LED flashes if the respective channel or several channels are selected in the configuration software.
2. Indication of a sensor break during measuring. The LED is permanently on when interrupting the sensor current.

4.4 Technical data (M-THERMO 8, M-THERMO 16)

		M-THERMO 8	M-THERMO 16
General		**HW ≥ V 4.80, FW ≥ V 3.20**	
Voltage supply	V DC	12, 24, 42, power supply, switch-off at voltage < 6 V	
Power consumption, typical	W	1.1	1.2
Operating temperature range Permanent/ 1 hour **Notice**	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C..	
Storage temperature range	°C	-55 ... +150	
Relative humidity	%	5 ... 95	
Enclosure		golden anodized aluminum, IP 67	
Dimensions (W * H * D/D) (without/with sockets)	mm	120 * 41 * 55/58	204 * 41 * 55/58
Weight	g	320	630
Thermocouple input		**electrically isolated**	
Overvoltage protection	V	±50	
Galvanic isolation Input ↔ Device supply Input ↔ Input	 V V	 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200	
Range type K (Ni10Cr/NiAl)	**°C**	**-60 to 1370**	
Resolution	°C	≤ 0.174 (≥ 13 Bit)	
Characteristic linearization		look-up table, ≥ 13 Bit	
Cold junction compensation (Reference temperature over RTD)	Pt100	2	4
Accuracy at 25 °C ambient temperature and measured temperature of: -60 °C ... 1000 °C / 1000 °C ... 1370 °C	%	±0.035 % / ±0.035 % + 3 K	
Drift at ambient temperature: -40 °C ... +85 °C/+85 °C ... +120 °C	ppm/K	±20 / ±30	
Input resistance, approx	MΩ MΩ	1 (sensor break detection active) 10 (sensor break detection not active)	
Align of the AD converter		before acquiring a value	
Sensor break detection		can be activated with the software	
Status LED at the input		not available	1. Identification of the respective channel 2. Sensor break displaying in acquisition mode
Hardware filter	Hz	1.0, filter type R-C-low pass 1st order	
Channel sample rates	Hz	1/ 2/ 5/ 10/ 20	
Aggregate sample rate	Hz	max. 160	max. 320
CAN output		**2.0 B, electrically isolated**	
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2	
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned	
Configuration interface		CAN	

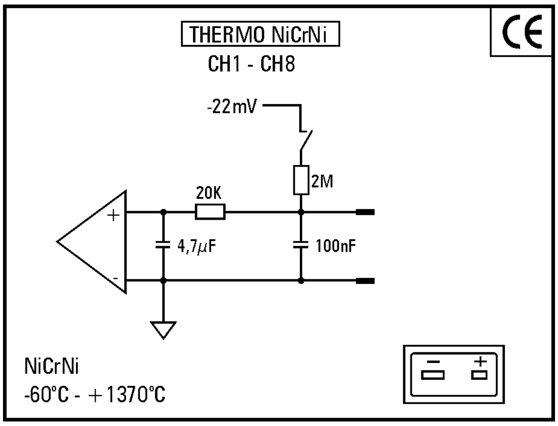
4.5 Technical data (M-THERMO2)

General		
Voltage supply	V DC	6 to 36
Power consumption, typical	W	1.1
Operating temperature range Permanent/ 1 hour **Notice**	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C..
Storage temperature range	°C	-55 ... +150
Relative humidity	%	5 ... 95
Enclosure		golden anodized aluminum, IP 67
Dimensions (W * H * D)	mm	106 * 30 * 50
Weight	g	250
Thermocouple input		**electrically isolated**
Galvanic isolation Input ↔ Device supply Input ↔ CAN Input ↔ Input	 V V V	 nominal voltage ±100 / pulse voltage ±500 nominal voltage ±100 / pulse voltage ±500 nominal voltage ±100 / pulse voltage ±500
Range type K (Ni10Cr/NiAl)	**°C**	**-60 to 1370**
Resolution	°C	≤ 0.087 (≥ 14 Bit)
Characteristic linearization		look-up table, 15 Bit
Cold junction compensation (Reference temperature over RTD)		each input with Pt100
Accuracy at 25 °C ambient temperature	%	±0.035 % of total range
Drift at ambient temperature: -40 °C ... +125 °C	ppm/K	±40
Input resistance, approx	MΩ MΩ	2.6 (sensor break detection active) 4.1 (sensor break detection not active)
Align of the AD converter		before acquiring a value
Sensor break detection		can be activated with the software
Status LED at the input		1. Identification of the respective channel 2. Sensor break displaying in acquisition mode
Hardware filter	Hz	1.0, filter type R-C-low pass 1st order
Channel sample rates	1/min Hz	1/ 2/ 5/ 10 1/ 2/ 5/ 10/ 20/ 50/ 100
Aggregate sample rate	Hz	max. 800
CAN output		**2.0 B, electrically isolated**
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned
Configuration interface		CAN

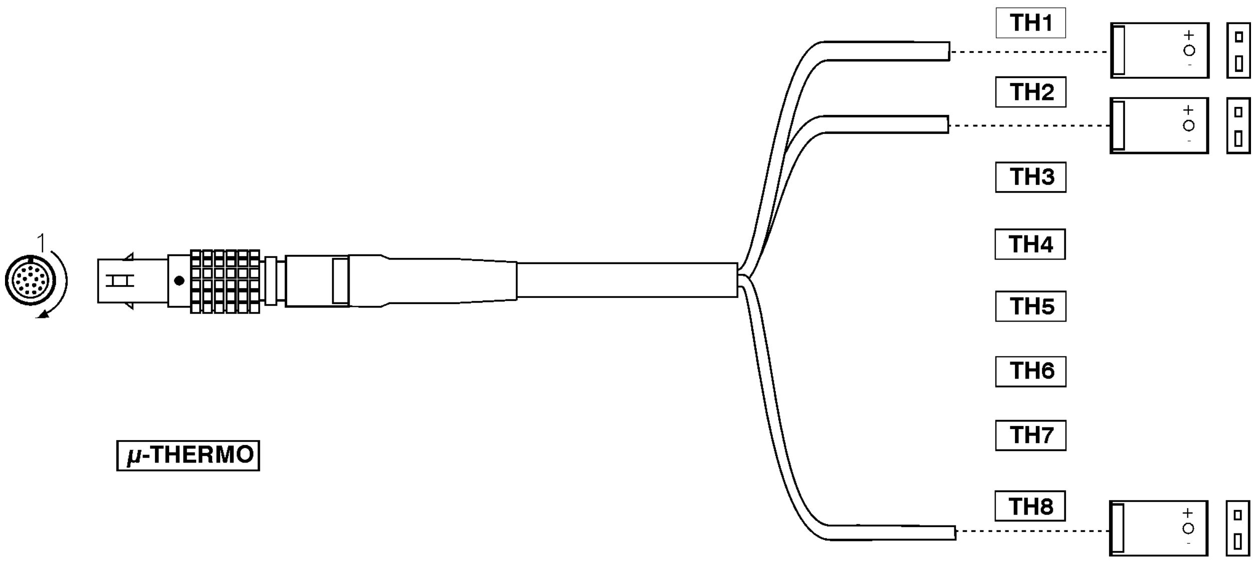
5 µ-THERMO

5.1 Temperature acqusition with thermocouples

µ-THERMO offers temperature acquisitions (range –60 °C to +1370 °C / -76 °F to 2498 °F) with thermocouples of K type as 8 channel version with a 16-pin Lemo socket. 2 PT resistors in an isothermal block calculate the thermo-electric voltage and provide the cold junction compensation. For providing exact results within the entire acquisition range, the non-linear characteristic of the thermocouple is adjusted by an internal linearization table. An optional impressed current through the sensor allows a sensor break detection, which is activated within the software.



5.2 Input cable 625-506.xxx



Anschlußbelegung / Connection

Lemo-Stecker, 16-pol. NiCrNi (schwarz) Lemo male, 16-pol. NiCrNi (black)		8x SUB-MIN-Kupplung, 2-pol. (grün) 8x SUB-MIN-coupling, 2-pol. (green)							
Pin-Nr. Pin-Nº	**Bezeichnung Designation**	**Litze-Nr. / Farbe Wire-Nº / Colour**							
THERMO-IN		TH1	TH2	TH3	TH4	TH5	TH6	TH7	TH8
1	TH-IN1- (Ni)	gn -							
2	TH-IN1+ (NiCr)	ws+							
3	TH-IN2- (Ni)		gn -						
4	TH-IN2+ (NiCr)		ws+						
5	TH-IN3- (Ni)			gn -					
6	TH-IN3+ (NiCr)			ws+					
7	TH-IN4- (Ni)				gn -				
8	TH-IN4+ (NiCr)				ws+				
9	TH-IN5- (Ni)					gn -			
10	TH-IN5+ (NiCr)					ws+			
11	TH-IN6- (Ni)						gn -		
12	TH-IN6+ (NiCr)						ws+		
13	TH-IN7- (Ni)							gn -	
14	TH-IN7+ (NiCr)							ws+	
15	TH-IN8- (Ni)								gn -
16	TH-IN8+ (NiCr)								ws+

All input cables are also available in different lengths, as well as, with further plug configurations.

5.3 Specific input settings

The break detection and the averaging are activated within the configuration dialog **Thermo**.

5.3.1 Break detection

A low current flows through the thermocouple at activated sensor break detection, which has no influence on the measuring result. If this flow is interrupted (sensor break), the result is –Fullscale. A distinction between –Fullscale by sensor break and real –Fullscale value is not possible. But the value –Fullscale is rarely possible. The break detection can therefore be used for identifying errors.

5.3.2 Averaging

In order to reduce the noise level in a signal, M-THERMO offers the ability to activate the averaging. The average value of the signals is calculated online over a period of the last 4 CAN sampling periods.

With a sampling rate of 10 Hz, the floating average is calculated online out of the 4 previous CAN outputs and sent with the defined updating rate (here 10 Hz).

Please also refer to Averaging at 4.3.2 M-THERMO

5.4 Technical data

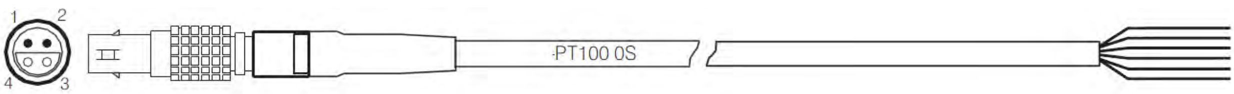
General		Valid for HW version ≥ 5.20 and FW-Version ≥ 3.20
Voltage supply	V DC	12, 24, 42, power supply, switch-off at voltage < 6 V
Power consumption, typical	W	1.1
Operating temperature range Permanent/ 1 hour **Notice**	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C..
Storage temperature range	°C	-55 ... +150
Relative humidity	%	5 ... 95
Enclosure		golden anodized aluminum, IP 67
Dimensions (L * H * W)	mm	118 * 46 * 32
Weight	g	218
Thermocouple input		**electrically isolated**
Overvoltage protection	V	±50
Galvanic isolation Input ↔ Device supply Input ↔ Input	 V V	 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200
Range type K (Ni10Cr/NiAl)	**°C**	**-60 to 1370**
Resolution	°C	≤ 0.174 (≥ 13 Bit)
Characteristic linearization		look-up table, ≥ 13 Bit
Cold junction compensation (Reference temperature over RTD)	2	Pt100
Accuracy at 25 °C ambient temperature and measured temperature of: -60 °C ... 1000 °C / 1000 °C ... 1370 °C	%	±0.035 % / ±0.035 % + 3 K
Drift at ambient temperature: -40 °C ... +85 °C/+85 °C ... +120 °C	ppm/K	±20 / ±30
Input resistance, approx	MΩ MΩ	1 (sensor break detection active) 10 (sensor break detection not active)
Align of the AD converter		before acquiring a value
Sensor break detection		can be activated with the software
Hardware filter	Hz	1.0, filter type R-C-low pass 1st order
Channel sample rates	Hz	1/ 2/ 5/ 10/ 20
Aggregate sample rate	Hz	max. 160
CAN output		**2.0 B, electrically isolated**
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned
Configuration interface		CAN

6 M-RTD2

6.1 Temperature acqusition with RTDs (Pt100)

M-RTD2 offers temperature acquisitions (range –50 °C to +450 °C / -58 °F to 842 °F) with RTD sensors (Pt100 resistor). The 4-wire sensor connection ensures good accuracy even for long distance sensor cables.

6.2 Input cable 670-937.xxx



Anschlußbelegung / Connection

Lemo-Stecker 0S, 4-pol. (schwarz)
Lemo-male 0S, 4-pol. (black)

Pin-Nr. Pin-№	Bezeichnung Designation	Litze-Nr. / Farbe Wire-№ / Colour
1 (P)	PT IN +	1 white
2 (P)	I OUT+	2 brown
3 (S)	PT IN -	3 red
4 (S)	I OUT-	4 black
Chassis	Shield	S (Shield, thick) blue

All input cables are also available in different lengths, as well as, with further plug configurations.

6.3 Specific input settings

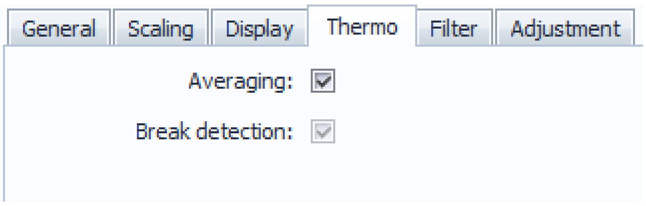
6.3.1 Scaling

The settings for the sensor range are fixed for Pt100 RTDs. Physical range default settings are equal to the sensor range. The user can modify the physical range for individual scaling.

6.3.2 Averaging

Enter the **Thermo** tab to activate the moving average function.

The sensor break detection is always activated.



The monitoring of the constant current through the RTD is used to detect a sensor break. A distinction between –Fullscale by sensor break and real –Fullscale value is supported.

6.4 Technical data

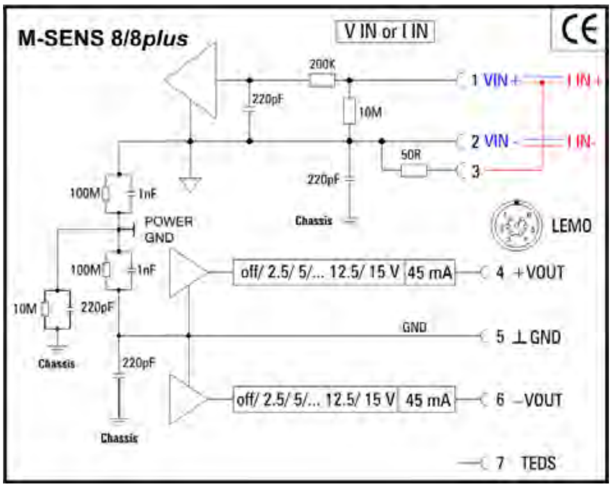
General		
Voltage supply	V DC	9 to 36, switch-off at voltage < 6 V
Power consumption, typical	W	2.5
Operating temperature range Permanent/ 1 hour **Notice**	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C..
Storage temperature range	°C	-40 ... +150
Relative humidity	%	5 ... 95
Enclosure		golden anodized aluminum, IP 67
Dimensions (W * H * D)	mm	106 * 43 * 60
Weight	g	400
RTD input		**electrically isolated**
Galvanic isolation Input ↔ Device supply Input ↔ Excitation Input ↔ CAN Input ↔ Input	 V V V V	 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200
Range Pt100	**°C**	**-50 to 450**
AD converter resolution (ADC SAR)	Bit	16
Accuracy at ambient temperature Ta = 25 °C Ta = -40 °C to 85 °C Ta = -40 °C to 125 °C	 K K K	 ±0.10 K (0.02 % of total range) ±0.60 K (0.12 % of total range) ±1.25 K (0.25 % of total range)
Hardware filter	Hz	150 Hz, filter typ Butterworth 8-pole
Channel sample rates	1/min Hz	1/ 2/ 5/ 10 1/ 2/ 5/ 10/ 20 / 50/ 100
Aggregate sample rate	Hz	max. 400
CAN output		**2.0 B, electrically isolated**
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned
Configuration interface		CAN

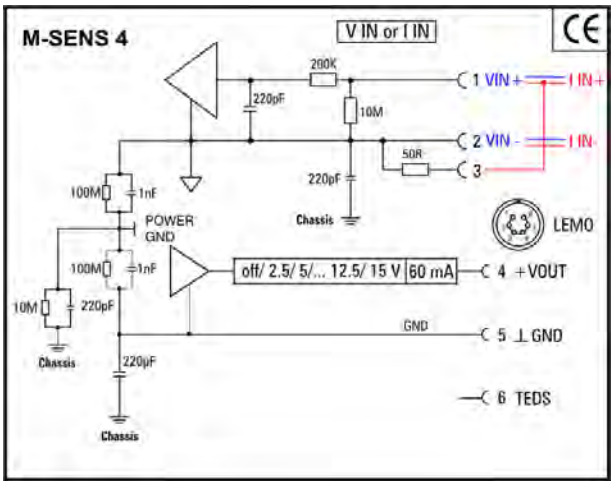
7 M-SENS, M-SENS2, M-SENS 8/8plus

7.1 Voltage/Current acquisition with sensor excitation

The M-SENS is an universal measuring device for acquiring voltages, currents, and sensor signals of active sensors. It provides 4 or 8 analog inputs and allows the setting of different voltage and current acquisition ranges, as well as, different channel sampling rates.

The channels and the separately adjustable sensor supply voltages are electrically isolated to each other, to the other channels, to the supply voltage, and to the CAN bus.





The sockets for the inputs are available in Lemo. Other sockets and ODU versions (Fips) on request.

7.2 Input cable 670-xxx.xxx

7.2.1 Input cable 670-807.xxx (M-SENS 4, SIM-SENS)

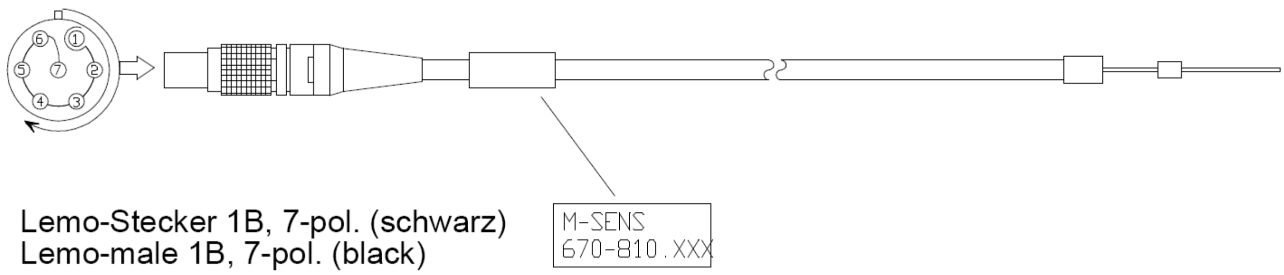
Anschlußbelegung / Connection

Lemo-Stecker 1B, 6-pol. (schwarz)
Lemo-male 1B, 6-pol. (black)

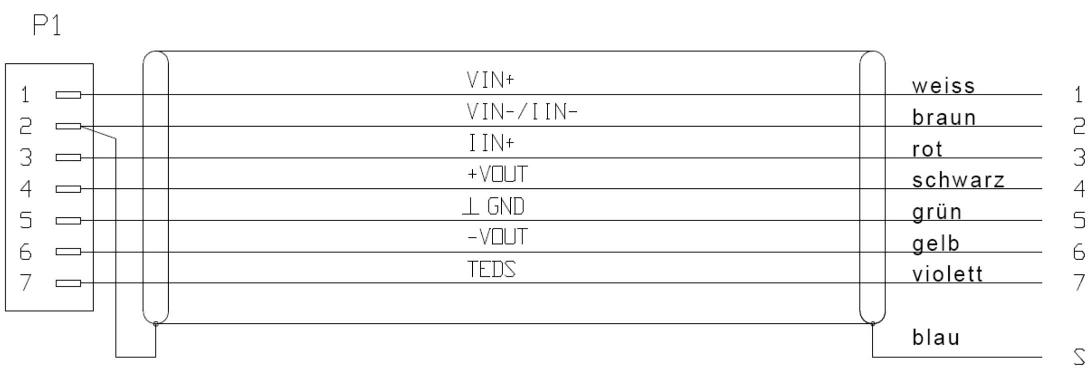
Pin-Nr. Pin-№		Bezeichnung Designation	Litze-Nr. / Farbe Wire-№ / Colour
1		VIN +	1 white
2	Shield	VIN -/ IIN -	2 brown
3		IIN +	3 red
4		+ VOUT	4 black
5		⊥ GND	5 green
6		- VOUT	6 yellow
			S (Shield, thick) blue

Only M-SENS 8 and M-SENS 8plus provide a negative sensor supply via pin 6. M-SENS reserves this pin for TEDS.

7.2.2 Input cable 670-810.xxx (M-SENS 8 / 8plus)



Lemo-Stecker 1B, 7-pol. (schwarz)
Lemo-male 1B, 7-pol. (black)



All input cables are also available in different lengths, as well as, with further plug configurations.

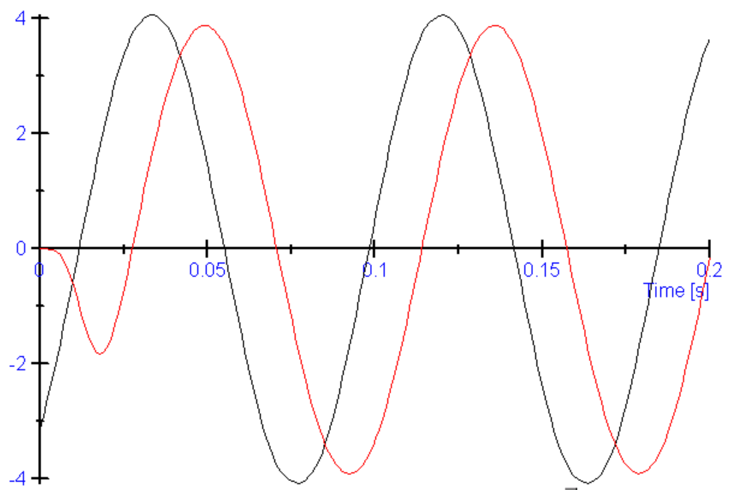
7.3 Input / Principle details

7.3.1 Filter in the measurement engineering - Why do we use filters?

Filters of analog measuring amplifiers are used for avoiding interrupting frequencies (frequency spectra, which do not contribute to the signal and/or which cannot be processed by the system). A low pass filter, which reduces the amplitudes of the frequencies above a specific cut-off frequency, is usually used for avoiding negative effects to the useful signal. The threshold in the range of the cut-off frequency (the barrier between the useful and the unrequested signal) is continuous.

Depending on the measuring task, the following filter properties are to be respected:

- Useful signals below the cut-off frequency are also damped. (A damping of 3 dB at the cut-off frequency means a reduction of the initial signal of 30 %.)
- Filters always cause a time shifting (phase shifting) between the initial signal and the filtered one. The value of the phase shifting depends on the filter type (e.g. Bessel, Butterworth, Tschebyscheff) and the filter order (pole number).



Signal frequency: 12.5 Hz black: Ch2 without any filter red: Ch3 Filter 30 Hz

The image above shows the result of two inputs with the same input signal of 4 V amplitude and 12.5 Hz frequency.

Channel 2	black	without filter
Channel 3	red	with 30 Hz hardware filter (Bessel type)

Channel 3 clearly shows the damping, the phase shifting, as well as, the start oscillation of the filter.

7.3.2 Filter in the measurement engineering - How do we use filters?

Modern systems offer qualified hardware filters and, if applicable, additional software filters (Digital Signal Processor DSP).

Although today’s microprocessors provide a high processing power, the use of hardware filters is still essential. Especially when users cannot exclude that (periodic) signals can pass the AD converter and software filter, which cannot process the signals. Every sampling system follows Shannon’s sampling theorem whereby one must at least sample with twice the signal frequency. Otherwise, aliasing effects can occur, whereas the acquired frequency is considerably lower than the actual signal (see image below).

But this theoretic view is not sufficient for practical applications because the systems (compared to lab devices) do not have FFT analyzers (Fast Fourier Transformation) for calculating the initial frequency. The hardware filter frequency of IPETRONIK devices with voltage inputs (VIN, SENS) is approx. 1/10 of the maximum sampling rate e.g. 100 Hz at 1 kHz max. sampling rate.

Why do we additionally filter with DSP?

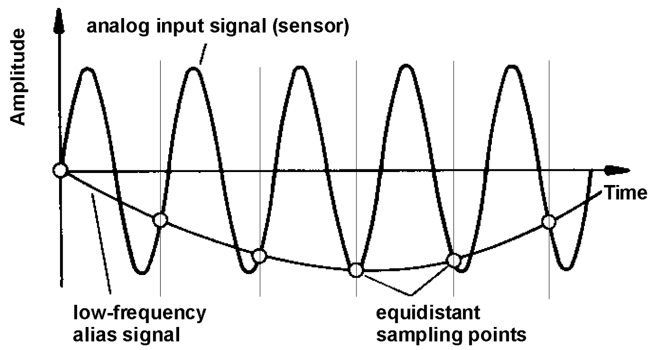
The hardware filter at the input excludes a distortion by frequency spectra above the system limit with the maximum sampling rate. Depending on the application, it can be required to lower the cut-off frequency.

Example:

M-SENS devices provide a switchable hardware filter with 150 Hz cut-off frequency. If the cut-off frequency is e.g. 50 Hz, interrupting frequency spectra (of devices with additional software filter) in the range between 50 Hz and the hardware filter frequency can be filtered with DSP. The filter frequency can be configured in defined steps up to the hardware filter frequency.

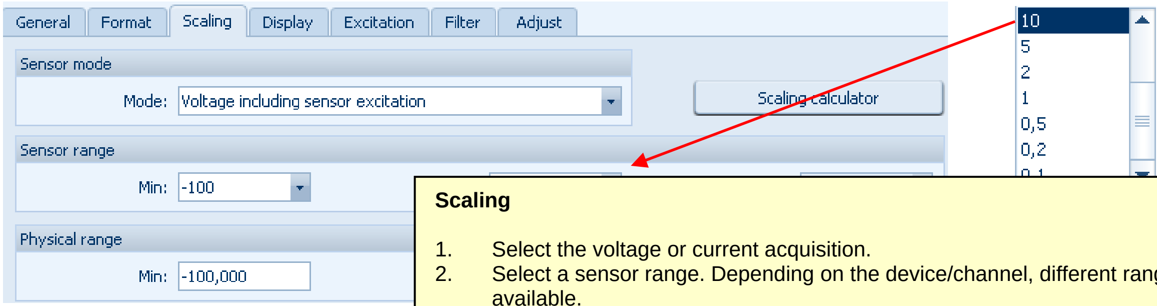
Aliasing effects in spite of hardware and software filter?

Despite sophisticated measurement engineering, errors can occur due to wrong settings. If, for example, a 100 Hz signal is acquired with a sampling rate of 100 Hz (also the output rate to the CAN bus). The system can independently acquire the correct signal, but the result is wrong because the sampling rate was set too low. This is especially valid for devices with DSP. The DSP always acquires the signal with a higher clock rate than the maximum adjustable sampling rate. If the signal is sent to the CAN bus with a lower sampling / output rate, the result does not reflect the initial signal.



7.4 Extended input settings

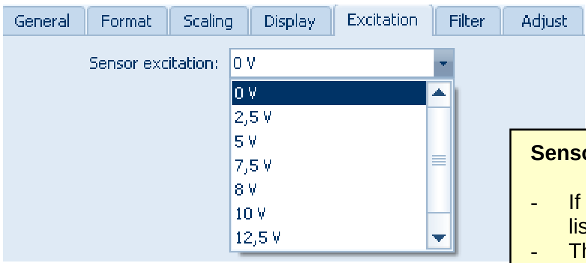
7.4.1 Scaling, measuring range



Scaling

1. Select the voltage or current acquisition.
2. Select a sensor range. Depending on the device/channel, different ranges are available.
3. Define a physical range and the unit with the scaling calculator – if required.

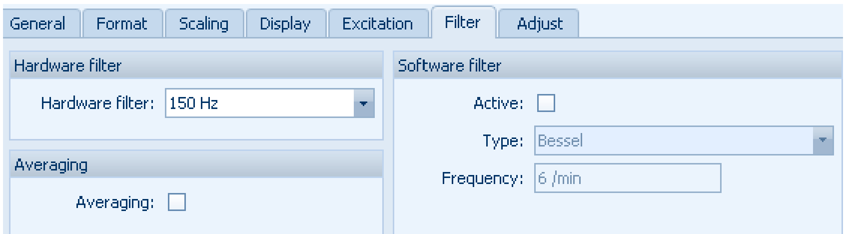
7.4.2 Sensor, initial excitation



Sensor

- If the sensor rquires a sensor excitation, select the initial excitation from the list. Depending on the device/channel, different voltages are available.
- The supply is electrically isolated to the input and channels nearby, as well as, to the device supply.

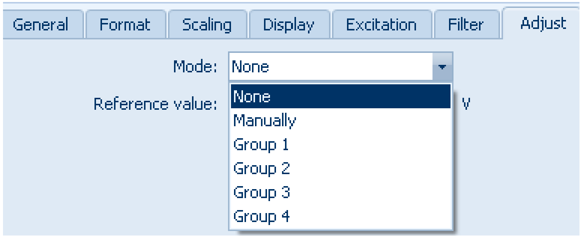
7.4.3 Filter, averaging



Filter

1. Activate the hardware filter for avoiding aliasing effects. This is always recommended for measuring with periodic signals.
2. Activate the averaging (floating average) for smoothing unrequested signal interrupts or noise components.
3. Activate the software filter for additionally filtering the signal. Select the filter type (Bessel, Butterworth, Tschebychev) and the cut-off frequency (0.1 Hz...495.0 Hz, depending on the sampling rate).

7.4.4 Offset adjust



The offset adjustment is supported by the respective device from the following firmware version:
M-SENS, M-SENS 8 >= V3.12.07
*M-SENS 8*plus >= *V3.12.08*

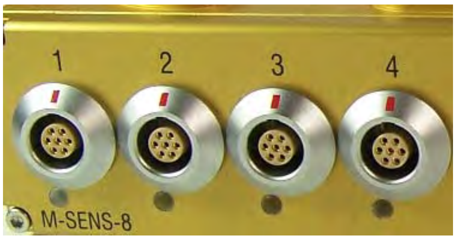
The calibration function with a broadcast command (IPEhotkey) also allows the offset adjustment during a running acquisition to a user defined target value (reference value). The following actions are permitted:

- **None** no offset calibration
- **Manually** only channels with this status are calibrated with the **Manual calibration** command
- **Group X** channels, which are assigned to a specific group (1…4), are calibrated with the desktop icon IPEhotkey and the **Calibration Group** command.
  The channel assignation to one group can also be effected for all devices (e.g. SENS type, STG, CAN*pressure* mixed in one group). A signal-based calibration is therefore possible.

7.4.5 Status-LED am Messeingang

Only M-SENS 8 and M-SENS 8*plus* devices have a status LED at every input. The respective LED indicates the following two states:

1. Identification of the respective channel during the configuration. The LED flashes if the respective channel or several channels are selected in the configuration software.
2. Indication of an overcurrent during measuring. The LED is permanently on if the maximum current load of the respective sensor excitation is exceeded.



7.5 Technical data

7.5.1 M-SENS, M-SENS2

		M-SENS	M-SENS2
General		**HW ≥ V 3.20**	
Voltage supply	V DC	9 to 36, switch-off at voltage < 6 V	
Power consumption, typical / maximum	W	3.0 / 9.0	3.0 / 9.0
Operating temperature range Permanent/ 1 hour **Notice**	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C..	
Storage temperature range	°C	-55 ... +150	
Relative humidity	%	5 ... 95	
Enclosure		golden anodized aluminum, IP 67	
Dimensions (W * H * D)	mm	120 * 41 * 55	106 * 43 * 58
Weight	g	370	380
Voltage / current input		**electrically isolated**	
Galvanic isolation Input ↔ Device supply Input ↔ Excitation Excitation ↔ Device supply Input ↔ Input	 V V V V	 ±100, t = 1 ms: ±200 ±100, t = 1 ms: ±200 ±100, t = 1 ms: ±200 ±100, t = 1 ms: ±200	 ±100 $U_{nominal}$, ±500 U_{pulse} ±100 $U_{nominal}$, ±500 U_{pulse} ±100 $U_{nominal}$, ±500 U_{pulse} ±100 $U_{nominal}$, ±500 U_{pulse}
Acquisition ranges			
Voltage unipolar (0 ...) Input resistance	V MΩ	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 60/ 100 10	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 60/ 100 10
Voltage bipolar (+/-) Input resistance	V MΩ	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 60/ 100 10	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 60/ 100 10
Current (unipolar, bipolar) Input resistance	mA Ω	0 ... 20, ±20 50	
Resolution	Bit	16	
Accuracy at $T_{Ambient}$ = 25 °C Voltagesn bipolar Voltages unipolar Currents bipolar / unipolar	 % % %	 ±0.05 ±0.13 ±0.30	 ±0.30 ±0.30 ±0.30
Drift at $T_{Ambient}$ -40 °C to +85 °C +85 °C to +105 °C +105 °C to +125 °C	 ppm/K ppm/K ppm/K	 ±40 ±80 ±120	 ±40 ±80 ±120

		M-SENS	M-SENS2
Filter, sample rates			
Hardware filter Frequency Type	Hz	150 8-pole Butterworth	500 8-pole Butterworth
Channel sample rates	Hz	1/ 2/ 5/ 10/ 20/ 50/ 100/ 200/ 500/ 1000/ 2000	
Aggregate sample rate	kHz	max. 8	max. 8
Sensor excitation		**single, galvan. isolated**	**single, galvan. isolated**
Selectable output voltage	V	off/ 2.5/ 5.0/ 7.5/ 10.0/ 12.5/ 15.0	off/ 2,5/ 5.0/ 7.5/ 10.0/ 12.5/ 15.0
Output current	mA	max. 60	max. 60
Short-circuit protection		Current limiting with safety shutdown at overcurrent	
Accuracy at $T_{Ambient}$ and voltage output 10 V +23 °C +85 °C +120 °C	 % % %	 ±0.20 ±0.40 ±0.60	 ±0.20 ±0.40 ±0.60
CAN output		**2.0 B, electrically isolated**	
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2	
Data in the CAN message Resolution / Format Sign	Bit	 8 / Byte or 16 / Word signed, unsigned	
Configuration interface		CAN	

7.5.2 M-SENS 8, M-SENS 8plus

		M-SENS 8	M-SENS 8*plus*
General			
Voltage supply	V DC	9 to 36, switch-off at voltage < 6 V	
Power consumption, typical / maximum	W	3.5 / 11.0	3.5 / 11.0
Operating temperature range Permanent/ 1 hour **Notice**	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C..	
Storage temperature range	°C	-55 ... +150	
Relative humidity	%	5 ... 95	
Enclosure		golden anodized aluminum, IP 67	
Dimensions (W * H * D)	mm	204 * 41 * 55	204 * 41 * 55
Weight	g	695	695
Voltage / current input		**electrically isolated**	
Galvanic isolation Input ↔ Device supply Input ↔ Excitation Input ↔ CAN Input ↔ Input	 V V V V	 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200 ±100, temporary (1 ms) ±200	
Acquisition ranges			
Voltage unipolar (0 ...) Input resistance	V MΩ	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 100 10	0.01/ 0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 100 10
Voltage bipolar (+/-) Input resistance	V MΩ	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 100 10	0.01/ 0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 100 10
Current (unipolar, bipolar) Input resistance	mA Ω	0 ... 20, ±20 50	
Resolution	Bit	16	
Accuracy at $T_{Ambient}$ = 25 °C Voltagesn bipolar Voltages unipolar Currents bipolar / unipolar	 % % %	 ±0.10 ±0.15 ±0.50	 ±0.06 ±0.10 ±0.40
Drift at $T_{Ambient}$ -40 °C to +85 °C +85 °C to +105 °C +105 °C to +125 °C (range ≥ 0.1 V) +105 °C to +125 °C (range 0.01 V)	 ppm/K ppm/K ppm/K ppm/K	 ±40 ±80 ±250	 ±40 ±80 ±250 ±450
Status LED at the input		1. Identification of the respective channel 2. Overcurrent displaying in acqusition mode	

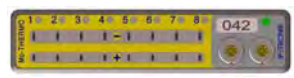
		M-SENS 8	M-SENS 8*plus*
Filter, sample rates			
Hardware filter Frequency Type	Hz	150 8-pole Butterworth	
Channel sample rates	Hz	1/ 2/ 5/ 10/ 20/ 50/ 100/ 200/ 500/ 1000/ 2000	
Aggregate sample rate	kHz	max. 16 (at 1 MBit/s data rate without additional bus load of further devices)	
Sensor excitation		**dual, electrically isolated**	
Selectable output voltage	V	off/ ±2.5/ ±5.0/ ±7.5/ ±8.0/ ±10.0/±12.5/ ±15.0	
Output current (independent from the output voltage setting)	mA	±25	±25
Initial current at an output voltage of ±2.5 or ±10.0 V ±5.0 or ±12.5 V ±7.5 or ±15.0 V	 mA mA mA	 max. ±30 max. ±40 max. ±45	 max. ±30 max. ±40 max. ±45
Derating The sum of the maximum output power of the sensor supplies is reduced with the increasing ambient temperature by this percentage per Kelvin!	%/K	-1,25 (from 85 °C ambient temperature)	
Short-circuit protection		Current limiting with safety shutdown at overcurrent	
Accuracy at $T_{Ambient}$ and voltage output 10 V -40 °C +23 °C +85 °C +120 °C	 % % % %	 ±0.50 ±0.30 ±0.50 ±0.70	 ±0.40 ±0.25 ±0.40 ±0.50
CAN output		**2.0 B, electrically isolated**	
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2	
Data in the CAN message Resolution / Format Sign	Bit	 8 / Byte or 16 / Word signed, unsigned	
Configuration interface		CAN	

8 Mc-THERMO

8.1 Voltage and temperature acquisition

Mc-THERMO is an universal measuring device for acquiring temperatures from –60 °C to +1370 °C / -76 °F to +2498 °F with thermocouples of the K type and voltages up to 30 V. Each of the 8 analog inputs can be configured with the configuration and measuring software IPEmotion.

The channels are electrically isolated to each other, to the other channels, to the supply voltage, and to the CAN bus.

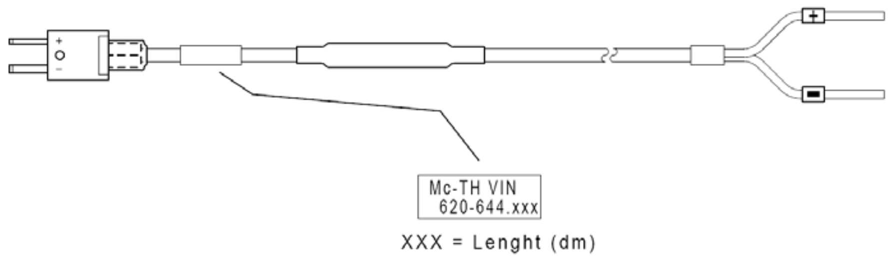


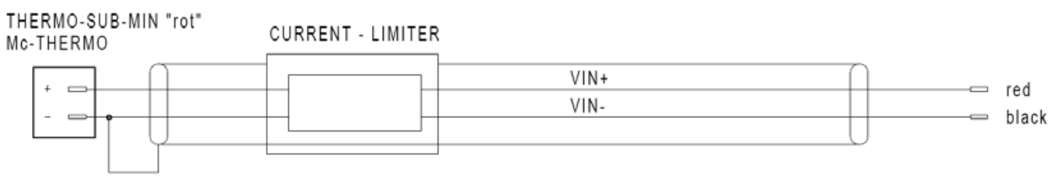
8.2 Input cable

Different input cables are available for acquiring the temperature and voltage signals. The thermocouple input cables are listed under the M-THERMO.

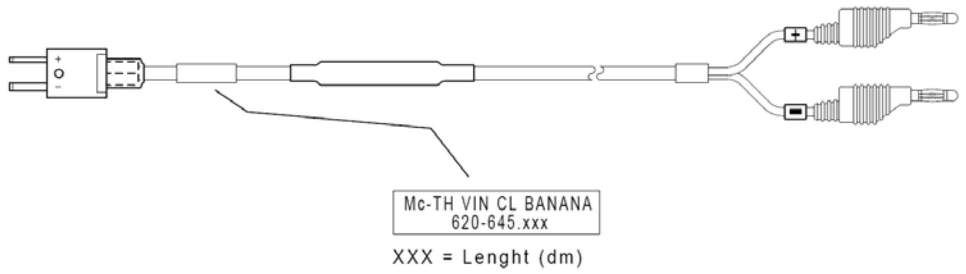
The following cables are used for the voltage measuring with Mc-THERMO. All Mc-THERMO VIN CL cables provide a current limiter for avoiding the danger of a short circuit due to the open ends of the connected thermo plug.

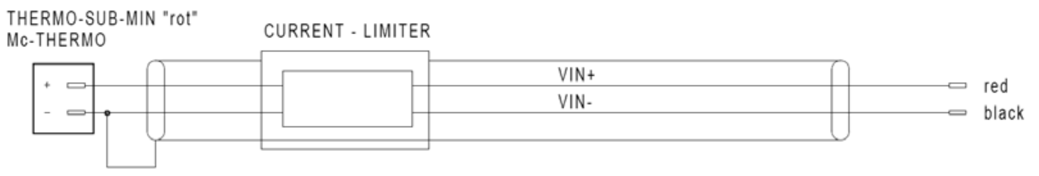
8.2.1 Input cable 620-644.xxx Mc-THERMO VIN CL Cable open



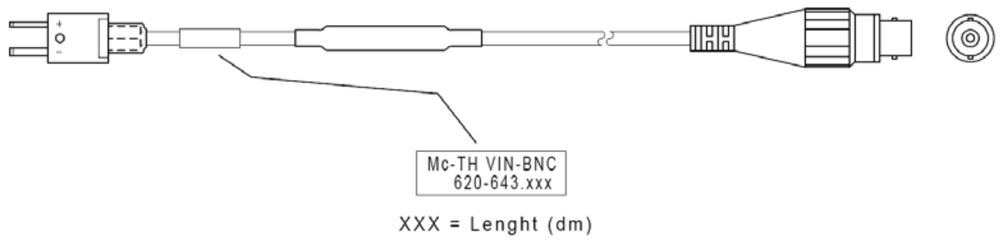


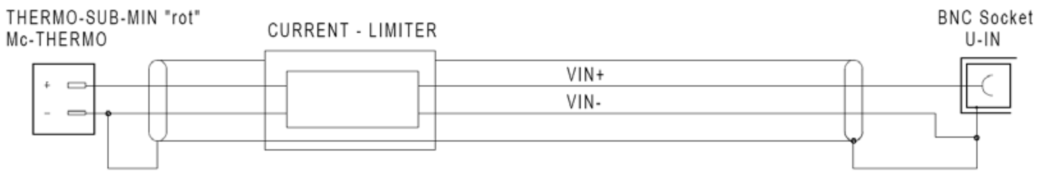
8.2.2 Input cable 620-645.xxx Mc-THERMO VIN CL Cable Banana





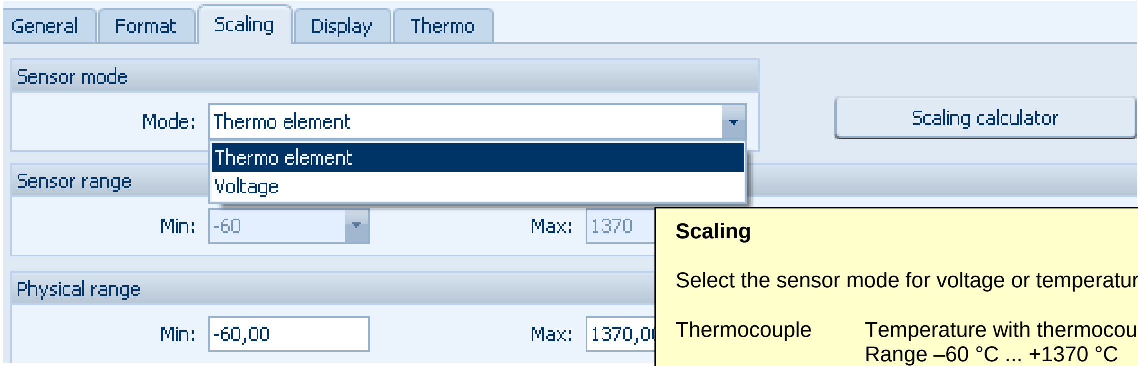
8.2.3 Input cable 620-643.xxx Mc-THERMO VIN CL Cable BNC/S





8.3 Extended input settings

8.3.1 Sensor mode

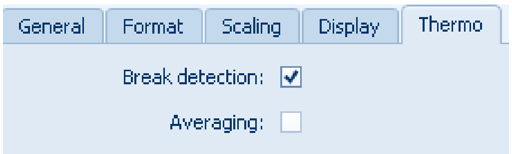


Scaling

Select the sensor mode for voltage or temperature acqusition.

Thermocouple	Temperature with thermocouple K type, Range –60 °C ... +1370 °C
Voltage	Voltage Range –30 V ... +30 V

8.3.2 Break detection and averaging



Thermo

Break detection	Activates the sensor break detection
Averaging	Activates the floating averaging out of previous averages

8.4 Technical data

General		
Voltage supply	VDC	6 to 36
Power input, typical	W	1.1
Working temperature range	°C	-40 ... +125 (Continuous operation) An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C.
Storage temperature range	°C	-55 ... +150
Relative humidity	%	5 ... 95
Input sockets Front membrane color acc. to DIN IEC 584 Front membrane color acc. to ANSI MC 96.1		Miniature thermocouple sockets green yellow
Enclosure		Aluminium, nature anodized, IP 65
Dimensions (W*H*D)	mm	106 * 24* 50
Weight	g	215
Temperature / Voltage input		**electrically isolated**
Input voltage max.	V	±50 (permanent), ±100 (t < 2ms)
Galvanic separation Input ↔ Device supply Input ↔ CAN all inputs	 V V V	 ±50, temporary (2 ms) ±200 ±50, temporary (2 ms) ±200 ±50, temporary (2 ms) ±200

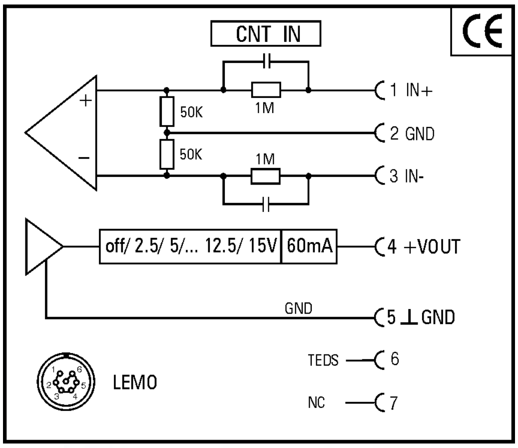
Temperature measuring range	**°C**	**-60 to 1370**
Sensor type		Thermocouple K type (Ni10Cr/NiAl)
Resolution	°C	≤ 0.087 (≥ 14 Bit) at 1 Hz sampling rate
Characteristic linearization		numeric, interpolated, resolution 15 bit
Cold junction compensation		PT100 for reference temperature measurement at every input
Accuracy [1] at 25 °C ambient temperature	% / K	±0.035 % of the temperature acqu. range at 1 Hz sampling rate
Drift [1] at ambient temperature: -40 °C to +85 °C +85 °C to +125 °C	 ppm/K ppm/K	 ±40 ±40
Input resistance, approx.	MΩ MΩ	2.6 (Sensor break detection active) 4.1 (Sensor break detection deactivated)
Hardware filter	Hz	10, R-C low pass filter type 1st order
Sensor break detection		can be activated with the software
Voltage measuring range	**V**	**±30**
Resolution	mV / Bit	≤ 0,92 (16 Bit)
Accuracy [1] at 25 °C ambient temperature	% / V	±0.1 % of the voltage acqu. range (±60 mV) at 1 Hz sampling rate
Drift [1] at ambient temperature: -40 °C to +85 °C +85 °C to +125 °C	 ppm/K ppm/K	 ±50 ±50
Input resistance, approx.	MΩ MΩ MΩ	4.1 @ T_A = 25 °C 3.6 @ T_A = 85 °C 1.2 @ T_A = 125 °C
Hardware filter	Hz	330, R-C low pass filter type 1st order
General input		
Resolution ADC	Bit	24
Calibration of the A/D chain		before acquiring a value
Status LED at the input		1. Identification of the respective channel during the configuration (LED flashes) 2. Sensor break displaying in acqu. mode (LED is permanently on)
Channel sampling rates	Hz	0.033/ 0.083/ 0.167/ 1/ 2/ 5/ 10/ 20/ 50/ 100
Aggregate sample rate	Hz	max. 800
CAN output		**2.0 B, electrically isolated**
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned
Configuration interface		CAN

9 M-FRQ, M-CNT2

9.1 Frequecy- / Cycle acquisition incl. sensor supply

The M-FRQ and M-CNT2 are universal counters. Main applications are the acquisition of inductive sensors in the fields ABS, wheel speed and fan speed. The following measuring modes are available: frequency, cycle, pulse, pause duration and duty cycle. The device provides 4 signal inputs with adjustable trigger thresholds, 2 voltage ranges for data evaluation and different channel sampling rates.

The channels and the separately adjustable sensor supply per channel are electrically isolated to each other, to the other channels, to the supply voltage, and to the CAN bus.

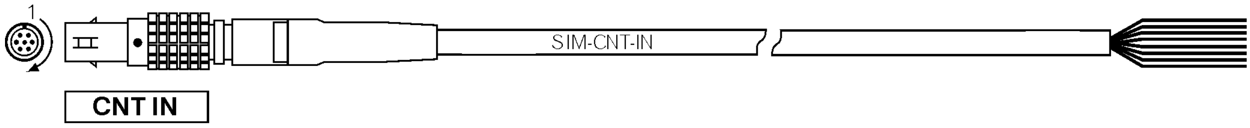


M-FRQ

M-CNT2

The sockets for the inputs are available in Lemo. Other sockets and ODU versions (Fips) on request.

9.2 Input cable 670-858.xxx



Anschlußbelegung / Connection

Lemo-Stecker 1B, 7-pol. (schwarz)
Lemo-male 1B, 7-pol. (black)

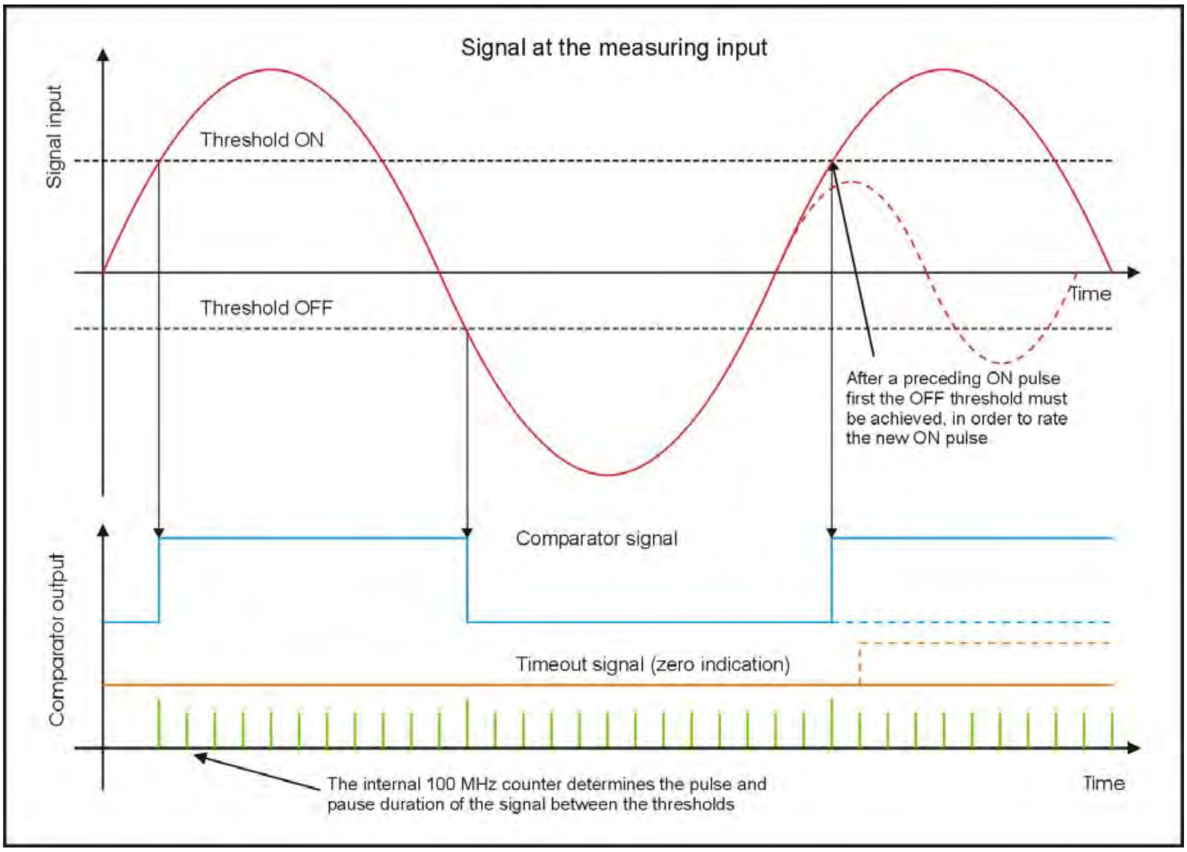
Pin-Nr. **Pin-№**	**Bezeichnung** **Designation**	**Litze-Nr. / Farbe** **Wire-№ / Colour**
1	IN +	1 white
2	GND	2 brown
3	IN -	3 red
4	+ Power	4 black
5	POWER GND	5 green
6	TEDS	6 yellow
7	NC	7 violet
Chassis	Shield	S (Shield, thick) blue

All input cables are also available in different lengths, as well as, with further plug configurations.

9.3 Input / Principle details

9.3.1 Measuring method

The analog and digital input signal is evaluated with a programmable comparator threshold (switching threshold, hysteresis) and the following 48 bit counter. The FPGA and the digital signal processor (DSP) convert the respective counter values online into a frequency output (and duty cycle or time period).



The input signal is compared with the defined switching thresholds by using a comparator (see image). The result is a square wave voltage similar to the frequency at the comparator output. The pulse and the interval duration of this square wave voltage is detected with the internal 100 MHz counter.

If the timeout expires without any detection of an ON threshold, the zero indication will output the user defined minimal value. The setting of the timeout is recommended in order to avoid time delays in signal evaluation. A correct signal evaluation is supported only with sequent detections of ON and OFF thresholds.

Frequency

The frequency is acquired with the interval duration acquisition described above. The reciprocal value of the counter result of the interval duration measurement is scaled and sent correspondingly to the measuring range setting.

Duty cycle

The counter value of the pulse duration is divided by the counter value of the interval duration and correspondingly scaled and sent to the measuring range setting.

If the frequency is too low (or 0 Hz), 0 % (low level) or 100 % (high level) is sent depending on the signal level.

The thresholds on and off do usually differ and cause different results of the pulse duration and the duty cycle if the signal edges are low, depending on the defined thresholds.

Interval duration

The interval duration is acquired with the acquisition described above. The counter value between two thresholds on is detected, scaled, and sent correspondingly to the measuring range setting.

Pulse duration

The pulse duration is acquired with the acquisition described above. The counter value between the threshold on and the threshold off is detected, scaled, and sent correspondingly to the measuring range setting.

The thresholds on and off do usually differ and cause different results of the pulse duration if the signal edges are low, depending on the defined thresholds.

Pause duration

The pause duration acquisition corresponds to the pulse duration acquisition with inverted input signal.

9.3.2 Status LED at the input

The status LED at the respective input indicates the acquisition of a frequency signal. This is the case if both switching thresholds of every value are reached (threshold on and off).

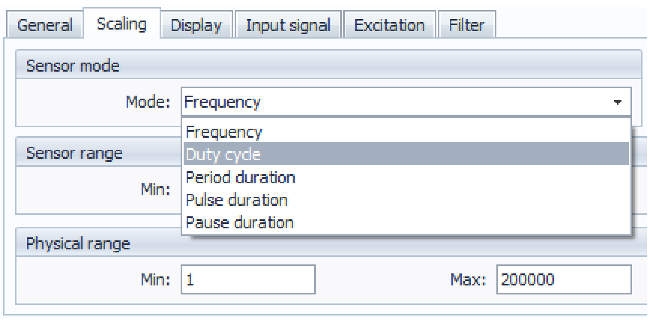
The status LED is on / flashes in time with the signal frequency if:

- the corresponding channel is active and
- the device is in the acquisition mode (acquiring data) and
- the switching thresholds are correctly defined.

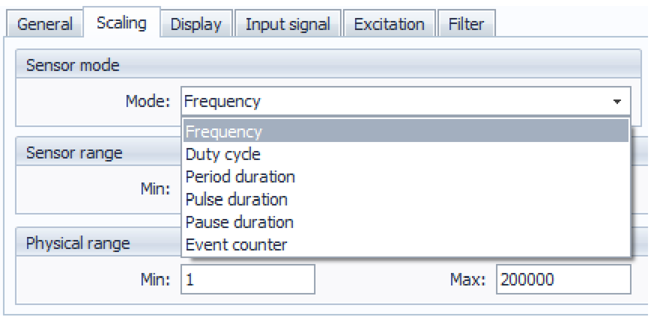
Due to the slowness of visual proceeding, only frequencies under approx. 10 Hz can be seen as a flashing. The LED is permanently on at higher signal frequencies.

9.4 Extended input settings

9.4.1 Scaling, measuring ranges



Scaling M-FRQ



Scaling M-CNT2

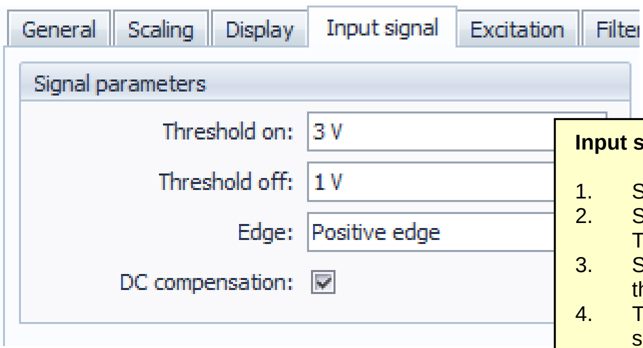
Scaling

1. Select the mode for frequency or period acquisition.
2. Select a sensor range. Depending on the device/channel, different ranges are available.
3. Define a physical range and the unit with the scaling calculator – if required.

Mode	Ranges			Remarks
	Min.	Max.	Unit	
Frequency	0 ... 200	0 ... 200	kHz	Maximum > Minimum minimum signal frequency 0.03 Hz maximum signal frequency 200 kHz
Duty cycle Range 0.01 % to 99.99 %	0 ... 100	0 ... 100	%	Maximum > Minimum minimum signal frequency 0.03 Hz maximum signal frequency: 10 kHz at 1 % duty cycle 250 kHz at 25 % duty cycle 500 kHz at 50 % duty cycle 250 kHz at 75 % duty cycle 10 kHz at 99 % duty cycle
Periodic duration	0 ... 200	0 ... 200	s	Maximum > Minimum maximum interval duration 200 s minimum interval duration 1 µs
Pulse duration	0 ... 200	0 ... 200	s	Maximum > Minimum maximum pulse duration 200 s minimum pulse duration 1 µs
Pause duration	0 ... 200	0 ... 200	s	Maximum > Minimum maximum pause duration 200 s minimum pause duration 1 µs

Select values >=1 Hz for the frequency with **Sensor range Min***! This avoids an unnecessary long response time until the value 0 Hz or –FS is sent if a signal is missing or has the value approx. 0 Hz. The maximum response time at 0 Hz is 40 s.*

9.4.2 Input signal



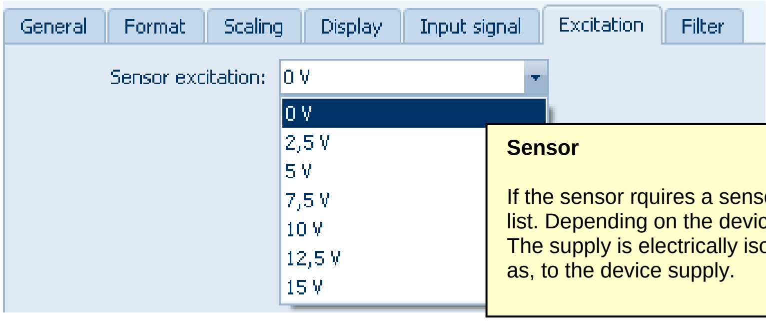
Input signal

1. Select the upper threshold with *Threshold on* in a range of +/-40 V.
2. Select the lower threshold with *Threshold off* in a range of +/-40 V. The lower threshold must always smaller than the upper one.
3. Select an edge for defining the positive or negative signal edge. If the negative edge is selected, the input signal will be inverted.
4. The DC compensation disables the direct current component in the signal with a passive high-pass (1-pole, 0.8 Hz cut-off frequency).

An oscilloscope is recommended for displaying the signal behavior for configuring the switching thresholds on and off. If the sensor signal does not exceed the threshold on or fall below the threshold off, no exact acquisition is possible. In this case, the value does not change although the revolutions per minute increase and the sensor is connected correctly. Correct the threshold values in the configuration and run a test acquisition.

Please note that a lot of speed sensors send an almost ideal square wave signal in the lower frequency range, but the graph changes with increasing frequency (> saw tooth). This can also be caused by external capacities e.g. a (long) connection cable to the sensor.

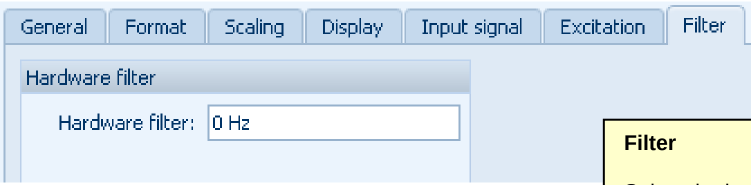
9.4.3 Sensor, initial excitation



Sensor

If the sensor rquires a sensor excitation, select the initial excitation from the list. Depending on the device/channel, different voltages are available.
The supply is electrically isolated to the input and channels nearby, as well as, to the device supply.

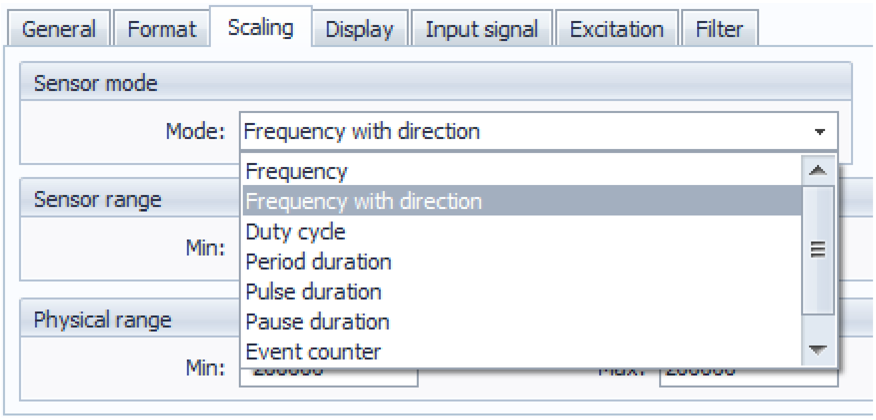
9.4.4 Filter



Filter

Select the hardware filter for avoiding aliasing effects. This is always recommended for measuring with periodic signals.

9.4.5 Mode (M-CNT2)



Channel 2 and Channel 4 provide the **Mode** tab to set the operating mode to detect the rotating direction in combination with input 1 resp. 3.

9.5 Technical data

		M-FRQ	M-CNT2
General			
Voltage supply	V DC	9 to 36, switch-off at voltage < 6 V	
Power input, typical / maximum	W	2.0 / 7.0	2.0 / 7.0
Working temperature range	°C	-40 ... +120/ +120 ... +125 An immediate safety shutdown runs at T > 125 °C, which is reset at T < 120 °C.	
Storage temperature range	°C	-55 ... +150	
Relative humidity	%	5 ... 95	
Enclosure		golden anodized aluminum, IP 67	
Dimensions (W * H * D)	mm	120 * 41 * 55	106 * 43 * 58
Weight	g	350	370
Voltage input		**electrically isolated**	
Galvanic isolation Input ↔ Device supply Input ↔ Excitation Excitation ↔ Device supply Input ↔ Input	 V V V V	 ±100, t = 1 ms: ±200 ±100, t = 1 ms: ±200 ±100, t = 1 ms: ±200 ±100, t = 1 ms: ±200	 ±100 $U_{nominal}$, ±500 U_{pulse} ±100 $U_{nominal}$, ±500 U_{pulse} ±100 $U_{nominal}$, ±500 U_{pulse} ±100 $U_{nominal}$, ±500 U_{pulse}
Adjustable thresholds Range 1 / (Quantization) Range 2 / (Quantization) Accuracy at $T_{Ambient}$ = 25 °C Accuracy at -40 < $T_{Ambient}$ < 120 °C	 V V % %	**Evalutation with voltage comparator** ±4 / (0.025) ±40 / (0.2) 3 8	
Signal evaluation		**Online with DSP**	
Frequency mode min. signal frequency max. signal frequency	 Hz kHz	 0.03 200	
Duty cycle mode min. signal frequency max. signal frequency Resolution	% Hz kHz µs	**Measuring range 0.01 % to 99.99 %** 0.03 10 at 1 % Duty cycle 250 at 25 % Duty cycle 500 at 50 % Duty cycle 250 at 75 % Duty cycle 10 at 99 % Duty cycle 1 or 1/100 $f_{g\ Filter}$ (greater value)	
Period, pulse, pause duration mode min. max. Resolution	 µs s µs	 1 200 1 or 1/100 $f_{g\ Filter}$ (greater value)	
Event counting mode			Reset functions: without reset, reset at clock, overflow, Up / down counting with detection of rotation direction

		M-FRQ	M-CNT2
Signal evaluation			
Internal time basis Accuracy at $T_{Ambient}$ = 25 °C Drift, -40 < $T_{Ambient}$ < 85 °C Drift, 85 < $T_{Ambientg}$ < 105 °C Drift, 105 < $T_{Ambient}$ < 125 °C	 % ppm/K ppm/K ppm/K	 0.01 (100 ppm) ±1.5 ±2.5 ±5.0	
Hardwarefilter Cut-off frequency Type Damping deviation $T_{Ambient}$ = 25 °C -40 < $T_{Ambient}$ < 120 °C	 Hz dB dB	 filter off, 1 Hz ... 30 kHz 5-pole Bessel ±1.5 ±3.0	
DC compensation lower cut-off frequency (-3 dB) Damping deviation $T_{Ambient}$ = 25 °C -40 < $T_{Ambient}$ < 120 °C	 Hz dB dB	 0.8 ±1.0 ±2.0	
Channel sample rates (= output rate at the CAN bus)	Hz	1/ 2/ 5/ 10/ 20/ 50/ 100/ 200/ 500/ 1000/ 2000/ 5000	
Aggregate sample rate. (depending on number of CAN-IDs and bit rate)	kHz kHz kHz kHz	max. 5 (without restriction) max. 4 x 2, max. two CAN-IDs busy max. 4 x 5, only one CAN-ID busy, 1 MBit/s max. 2 x 5, only one CAN-ID busy, 500 kBit/s	
Sensor excitation		**electrically isolated**	
Selectable output voltage	V	off/2.5/ 5.0/ 7.5/10.0/ 12.5/ 15.0	
Output current ((independent from the voltage setting)	mA	max. 60 (Short-circuit-proof, with safety shutdown at overcurrent)	
Accuracy at ambient temperature 23 °C / 85 °C / 120 °C	 %	and 10 V output voltage ±5.0 / ±6.0 / ±7.0	
CAN output		**2.0 B, electrically isolated**	
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2	
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned	
Configuration interface		CAN	

10 MultiDAQ

10.1 42 Channel multi input device T/ U/ I/ f

MultiDAQ is a 42 channel multi input module for data acquisition of temperatures through K-Type thermocouples, voltages/ currents incl. sensor excitation and frequency signals. Each input channel is equipped with a separate LED to indicate signal/ sensor status.

MultiDAQ provides the following number and types of inputs:

32	Thermocouple type K	-60 °C to +1370 °C (-76 °F to +2498 °F)
8	Voltage/ current incl. sensor excitation	up to ±100 V/ ±20 mA
2	Frequency/ period signals (voltage)	up to 200 kHz, voltage input range up to ±40 V

Each of the 42 inputs can be configured with the configuration and measuring software IPEmotion.

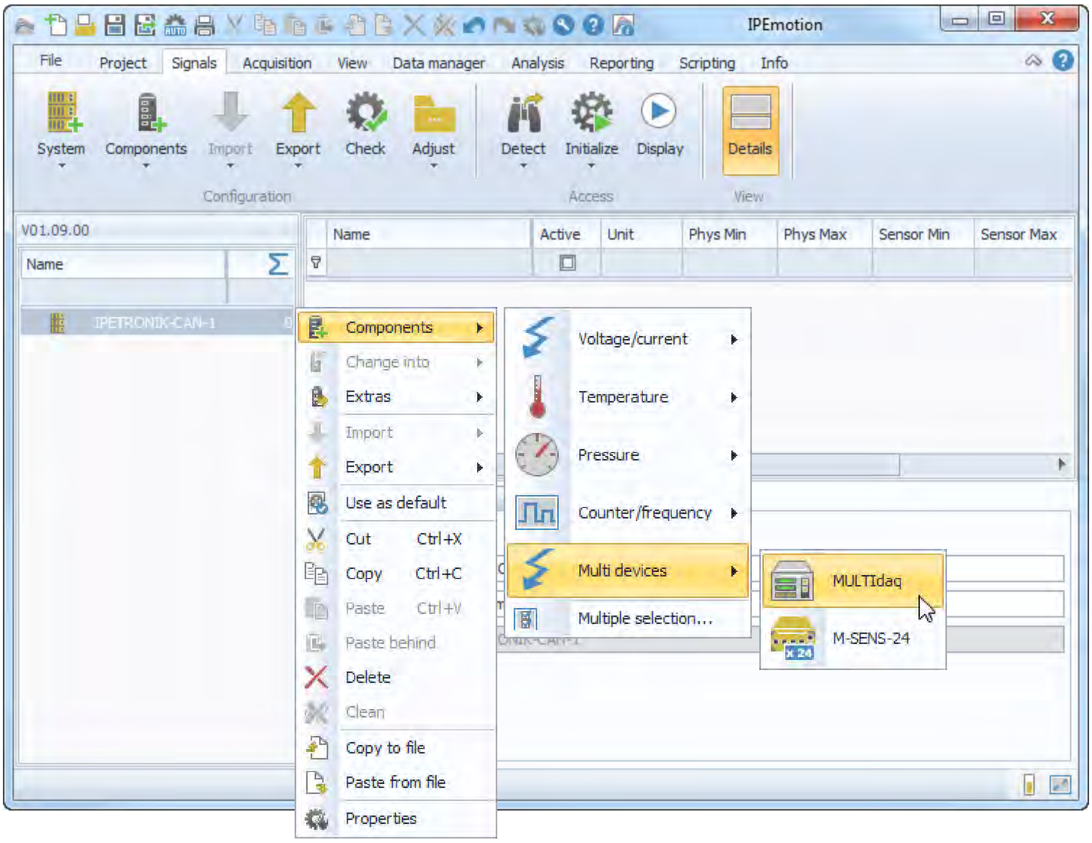
The channels are electrically isolated to each other, to the other channels, to the supply voltage, and to the CAN bus.

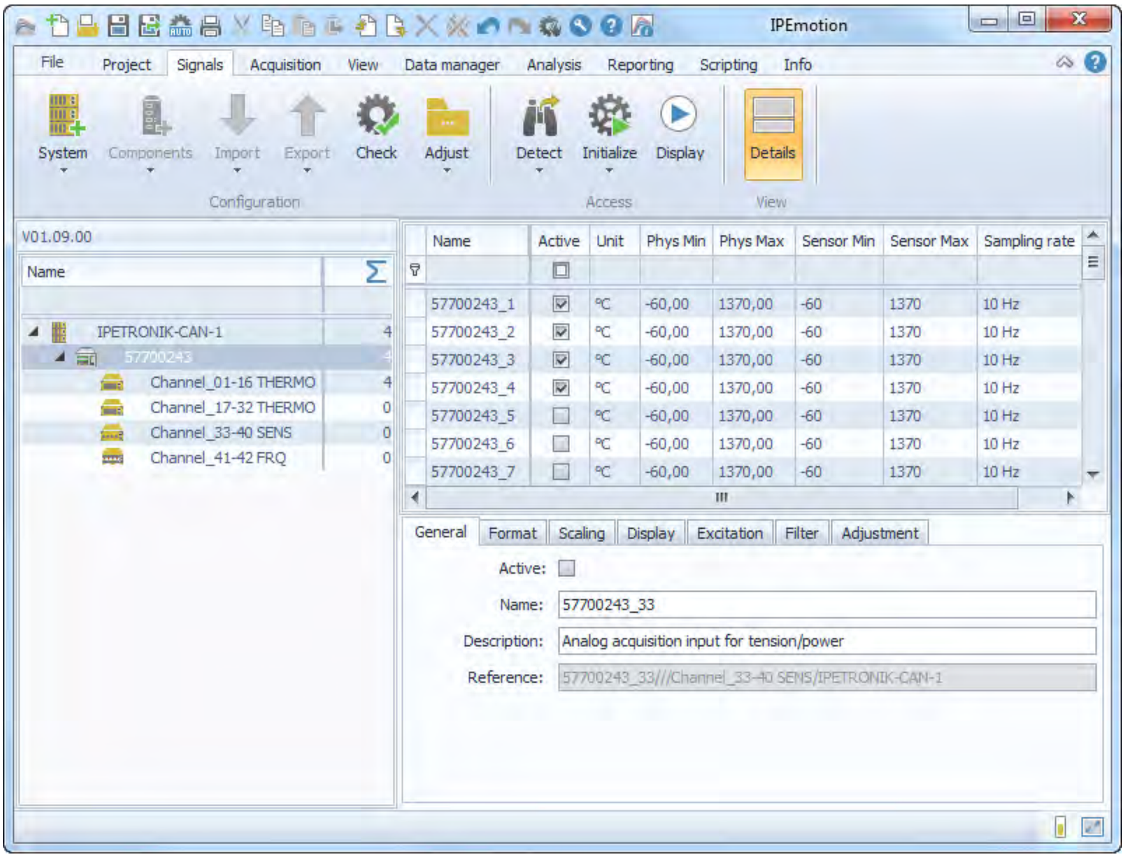
10.2 Input cable

Get more details regarding to the respective input cables:

Thermocouple inputs	refer to	4.2 M-THERMO, M-THERMO 16
Voltage/ current inputs	refer to	7.2 M-SENS 4, M-SENS 8/ 8plus
Frequency/ period inputs	refer to	9.2 M-FRQ

10.3 Create and configure MultiDAQ





Get more details regarding to the setting of the respective input channels:

Thermocouple inputs	refer to	4.3 M-THERMO, M-THERMO 16
Voltage/ current inputs	refer to	7.4 M-SENS 4, M-SENS 8/ 8plus
Frequency/ period inputs	refer to	9.3 M-FRQ

10.4 Technical data

General	
Measurement ranges Temperature	**-60 °C to +1370 °C (-76 °F to +2498 °F)**
Measurement ranges Voltage	**Covering input signals 0.1 V to 100 V**
Measurement ranges Current	**0 ... 20 mA, ±20 mA**
Measurement ranges Frequency/Period	**up to 200 kHz / 10 µs (100 kHz)**
Input voltage (IN+ ↔ IN-)	max. ±100 V, short-time (1 ms) ±200 V
Channel sample rates	1/ 2/ 5/ 10/ 50/ 100/ 200/ 500/ 1000/ 2000 Hz
Voltage supply	6 VDC ... 36 VDC
Power consumption, typical maximum	6.0 W 17.0 W (max. load on all excitations)
Working temperature range	-40 °C ... +85 °C (-40 °F ... +185 °F)
Storage temperature range	-55 °C ... +125 °C (-67 °F ... +257 °F)
Relative humidity	5 ... 95 %
IP-Code (Ingress protection)	IP 67 (DIN EN 60529)
Dimensions (enclosure)	L261 mm x W116 mm x H55 mm (W10.28 in x W4.57 in x H2.17 in)
Weight	1950 g (4.30 lb)

Thermocouple input (bank 1 and 2)	32 inputs, electrically isolated
Sensor type	K-Type thermocouple (Ni10Cr/NiAl)
Measuring range type K (Ni10Cr/NiAl)	**-60 °C to 1370 °C (-76 °F to 2498 °F)**
AD converter resolution	16 Bit
Linearization look-up table resolution	≥ 13 Bit / better than 0.174 °C (0.31 °F)
Cold junction compensation	8 PT100 (RTD) to measure the reference temperature
Input resistance	approx. 1 MΩ with activated sensor break detection approx. 10 MΩ with inactivated sensor break detection
Input channel status LED	1. Identify the respective channel in configuration mode (LED flashes) 2. Identify sensor break in measuring mode (LED lights continuously)
Align of the AD converter	before processing each measuring value
Sensor break detection	activated per software on command
Hardware filter	1.0 Hz, filter type single pole RC low-pass
Channel sample rates	1/ 2/ 5/ 10/ min 1/ 2/ 5/ 10/ 20 Hz
Total sampling rate per bank	max. 320 Hz

Voltage / Current input (bank 3)	8 inputs, electrically isolated
Voltage ranges	
Voltage unipolar (0 ...) Input resistance Voltage bipolar (+ / -) Input resistance Current unipolar (0 ...) / bipolar (+ / -) Input resistance	0.1/ 0.2/ 0.5/ 1/ 2/ 5/ 10/ 20/ 30/ 50/ 100 V 10 MΩ ±0.1/ ±0.2/ ±0.5/ ±1/ ±2/ ±5/ ±10/ ±20/ ±30/ ±50/ ±100 V 10 MΩ 0 ... 20 mA, ±20 mA 50 Ω

Signal resolution	16 Bit
Input channel status LED	1. Channel identification for configuration (LED flashes) 2. Current overload indication (LED on)
Offset adjust by broadcast command (Also supported during measurement!)	- manual offset adjust - offset adjust for all channels of a group
Hardware filter, switchable	150 Hz, filter type 8-pole Butterworth
Software filter (DSP), optional	cut-off frequency and filter type selectable
Channel sample rates	1/ 2/ 5/ 10/ 50/ 100/ 200/ 500/ 1000/ 2000 Hz
Total sampling rate per bank	max. 16 kHz (1 MBit/s data rate, no other devices)
Sensor excitation	**electricllay isolated**
Selectable output voltage	Off/ ±2.5/ ±5/ ±7.5/ ±10/ ±12.5/ ±15 VDC
Output current (short circuit proof) at Voutput ±2.5/ ±10.0 V at Voutput ±5.0/ ±12.5 V at Voutput ±7.5/ ±15.0 V	±25 mA (independent from output voltage) max. ±30 mA max. ±40 mA max. ±45 mA

Frequency / Counter input (bank 4)	**2 inputs, electrically isolated**
Adjustable trigger thresholds	
Quantization at range ±4 V Accuracy at 25 °C / -40 ... +125 °C	0.025 V 3 % / 8 %
Quantization at range ±40 V Accuracy at 25 °C / -40 ... +125 °C	0.2 V 3 % / 8 %
Signal modes	**Online calculated by DSP**
Frequency (min. / max. signal frequency)	0.03 Hz / max. 200 kHz
Duty cycle (range) min. signal frequency max. signal frequency (at 1 % accuracy) (Reduced accuracy at higher signal frequency and / or worst case duty cycle.) Resolution	0.01 % ... 99.99 % 0.03 Hz 10 kHz @ 1 % duty cycle (worst case) 500 kHz @ 50 % duty cycle (best case) 10 kHz @ 99 % duty cycle (worst case) 1 µ or 1/100 fC Filter (higher value)
Period duration, Pulse duration, Pause duration min. / max. duration, resolution	 1 µs / 200 s, 1 µ or 1/100 fC Filter (higher value)
Hardware filter, adjustable Attenuation Variance at 25 °C / -40 ... +125 °C	Off, 1 Hz ... 30 kHz, filter type 5-pole Bessel ±1.5 dB / ±3.0 dB
DC compensation Attenuation Variance at 25 °C / -40 ... +125 °C	0.8 Hz (lower cut-off frequency (- 3 dB) ±1.0 dB / ±2.0 dB
Channel sample rates	1/ 2/ 5/ 10/ 50/ 100/ 200/ 500/ 1000/ 2000/5000 Hz
Total sampling rate per bank (depends on number of CAN IDS and bit rate)	max. 4 kHz (without restriction) 2x 5 kHz (max. 1 CAN ID used @ 500 kBit/s data rate)
Sensor excitation	**electricllay isolated**
Selectable output voltage	Off/ 2.5/ 5/ 7.5/ 10/ 12.5/ 15 VDC
Max. output current	60 mA (short circuit proof and overload protected)

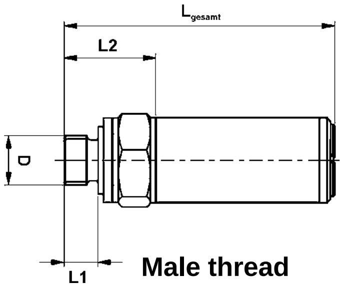
CAN output (bank 1, 2, 3, 4)	**CAN 2.0 B, electricllay isolated**
Selectable data transfer rate (bit rate)	up to 1 MBit/s according to ISO11898-2
CAN message data format (signal) Resolution (Format) Sign	 8 Bit (Byte) and 16 Bit (Word) selectable signed, unsigned
Configuration interface	CAN

11 CANpressure

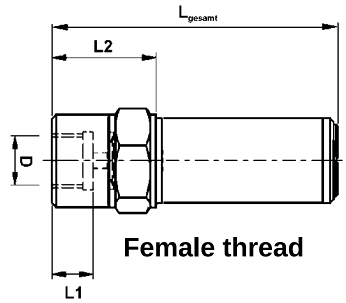
11.1 Pressure sensor with CAN output

CAN*pressure* is a pressure sensor with CAN output for relative or absolute pressure measurements with synchronous data acquisition up to 2 kHz sampling rate. The temperature is additionally acquired with a PT1000 directly at the piezoelectric element.

11.2 Pressure connections



Male thread



Female thread

Dimensions	D	L1	L2	Fastening torque	Wrench size
M 10 x 1 male	10 mm	8.5 mm	25.5 mm	17 ... 23 Nm	24 mm / 0.94 in
M 10 x 1 female	10 mm	9.5 mm	26.5 mm	17 ... 23 Nm	24 mm / 0.94 in
M 14 x 1,5 male	14 mm	9.5 mm	25.5 mm	17 ... 23 Nm	24 mm / 0.94 in
M 14 x 1,5 female	14 mm	10.5 mm	26.5 mm	17 ... 23 Nm	24 mm / 0.94 in
G ¼ male	13.2 mm	9.5 mm	25.5 mm	17 ... 23 Nm	24 mm / 0.94 in
G ¼ female	13.2 mm	10.5 mm	26.5 mm	17 ... 23 Nm	24 mm / 0.94 in

⚠ **Do not exceed the specified max. fastening torque!**

Pressure transducer (relative, absolut)	Overload pressure	Burst pressure
0 ... 1 bar / 0 ... 14.5 psi **0 ... 2 bar / 0 ... 29.0 psi** **0 ... 5 bar / 0 ... 72.5 psi** **0 ... 10 bar / 0 ... 145 psi** **0 ... 20 bar / 0 ... 290 psi** **0 ... 25 bar / 0 ... 363 psi**	3 x FS (Full Scale) 3 x FS 3 x FS 3 x FS 3 x FS 3 x FS	> 200 bar / 2,901 psi > 200 bar / 2,901 psi > 200 bar / 2,901 psi > 200 bar / 2,901 psi > 200 bar / 2,901 psi > 200 bar / 2,901 psi
0 ... 50 bar / 0 ... 725 psi **0 ... 100 bar / 0 ... 1,450 psi** **0 ... 250 bar / 0 ... 3,626 psi**	3 x FS (Full Scale) 3 x FS 3 x FS	> 850 bar / 12,328 psi > 850 bar / 12,328 psi > 850 bar / 12,328 psi
other pressure ranges	on request	
Medium compatibility Gases and fluids (also fuels and break fluids) up to 200 bar / 2,901 psi, other conditions on request		

11.3 Input / Principle details

Difference between relative and absolute pressure sensors

A pressure acquisition is always a comparative acquisition of pressure ratios between two different physical systems (acquisition and reference range). **Relative pressure sensors** use a variable reference as counter pressure (e.g. the atmospheric air pressure). Absolute pressure sensors acquire against a constant and calibrated reference (e.g. vacuum or defined pressure).

A sensor can only acquire either relative pressure or absolute pressure. Due to the mechanical sensor structure, the reference pressure is preset and therefore the pressure type. For measuring against both reference pressures, two different sensors are required.

Medium compatibility of the sensor

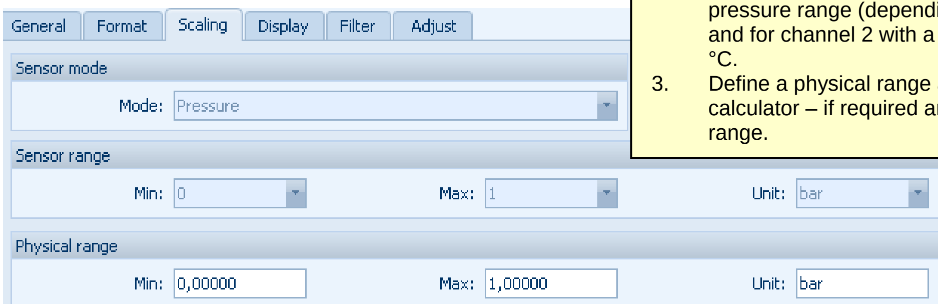
CAN*pressure* can be used for almost all media (incl. brake fluids and fuels). Restrictions are to be tested in particular cases before using very aggressive media like acids or high pressures and/or media temperatures.

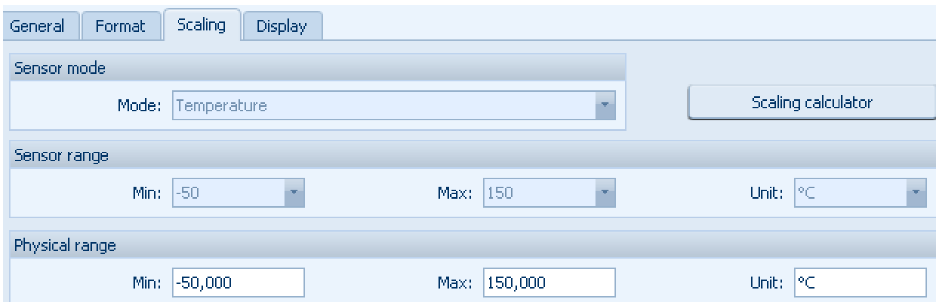
11.4 Extended input settings

11.4.1 Scaling

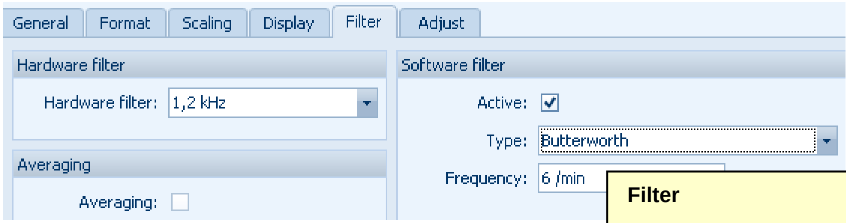
Scaling

1. The sensor mode is set as pressure for channel 1 and as temperature for channel 2.
2. The sensor range is set for channel 1 with the respective pressure range (depending on the CAN*pressure* version) and for channel 2 with a temperature range of –50 ... +150 °C.
3. Define a physical range and the unit with the scaling calculator – if required and if it does not match the real range.





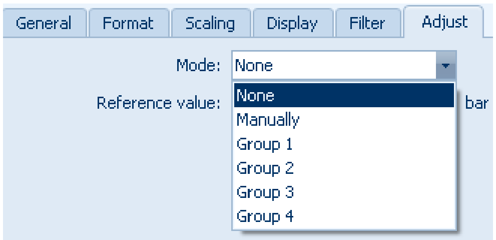
11.4.2 Filter, averaging



Filter

1. Activate the hardware filter for avoiding aliasing effects. This is always recommended for measuring with periodic signals.
2. Activate the averaging (floating average) for smoothing unrequested signal interrupts or noise components.
3. Activate the software filter for additionally filtering the signal. Select the filter type (Bessel, Butterworth, Tschebychev) and the cut-off frequency (0.1 Hz...495.0 Hz, depending on the sampling rate).

11.4.3 Adjust



The calibration function with a broadcast command (IPEhotkey) also allows the offset adjustment during a running acquisition to a user defined target value (reference value). The following actions are permitted:

- **None** no offset calibration
- **Manually** only channels with this status are calibrated with the **Manual calibration** command
- **Group X** channels, which are assigned to a specific group (1…4), are calibrated with the desktop icon IPEhotkey and the **Calibration Group** command.
  The channel assignation to one group can also be effected for all devices (e.g. SENS type, STG, CAN*pressure* mixed in one group). A signal based calibration is therefore possible.

11.5 Technical data

General		
Voltage supply	V DC	6 ... 36 Input threshold U >= 6 V
Power consumption, typical	W	< 0.7
Operationg temperature range	°C	-40 ... +125 (with safety shutdown)
Storage temperature range	°C	-55 ... +150
Relative humidity	%	5 ... 95
Enclosure		Stainless steel 4435
Pressure connection		M 10 x 1 / M 14 x 1,5 / G ¼ male and female thread available
IP protection class Relative / absolute pressure		IP 52 / IP 68
General input		**electrically isolated**
Electrical isolation		Signal – excitation supply CAN bus – excitation supply
Resolution (p, T)	Bit	16
Hardware filter, cut-off frequency f_C Type	Hz	1200, switchable 8-pole Butterworth
Software filter, minimum cut-off frequency f_{Cmin} maximale Grenzfrequenz f_{Cmin} Filter characteristics selectable	 Hz Hz	selectable in 0.1 Hz resp. 1 Hz steps 0.1 Hz @ 1 Hz f_{sample}, 10 Hz @ 2 KHz f_{sample} 0.4 Hz @ 1 Hz f_{sample}, 496 Hz @ 2 KHz f_{sample} depending on sampling rate and selected filter type Bessel, Butterworth, Chebyshev, Chebyshev invers, each 8-pole
Channel data rates (output at the CAN-Bus)	Hz	1/ 2/ 5/ 10/ 20/ 50/ 100/ 200/ 500/ 1000/ 2000
Signal amplifier		
Accuracy pressure signal	%	0.5 % FS (nominal pressure) TEB (-40 °C ... +125 °C) all measuring uncertainties included
Measuring range of temperature signal Accuracy of temperature signal	°C K	-40 ... +150 ±3.0 (total temperature and pressure range)
Special funcons Pressure offset adjust		offline, at running acquisition, to target value
CAN output		**2.0 B, electrically isolated**
Programmable data rate	Bit/s	max. 1 MBit/s acc. to ISO11898-2
Data in the CAN message Resolution / Format Sign	 Bit	 8 / Byte or 16 / Word signed, unsigned
Configuration interface		CAN

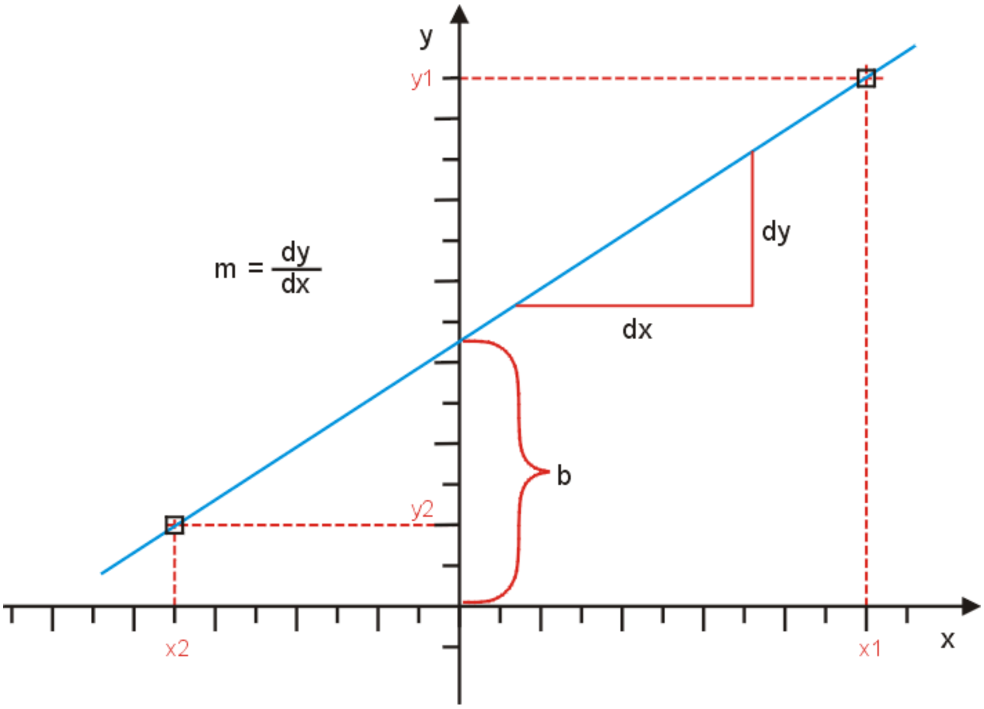
12 Appendix

12.1 Linear signal scaling

The conversion of a raw value (binary value, e.g. in a CAN message) into a physical value (value with unit) is effected with the scaling. IPETRONIK offers the scaling calculator and supports linear scaling with the line equation as factor/offset or 2 point scaling.

The scaling of a voltage or current signal (sensor output) into a corresponding physical or percentage value is effected in the same way. The following examples show the connections.

Mathematical basis for the line equation



Point slope form

y = m * x + b b = y - m * x m = Slope b = Constant (Offset)

2 points form

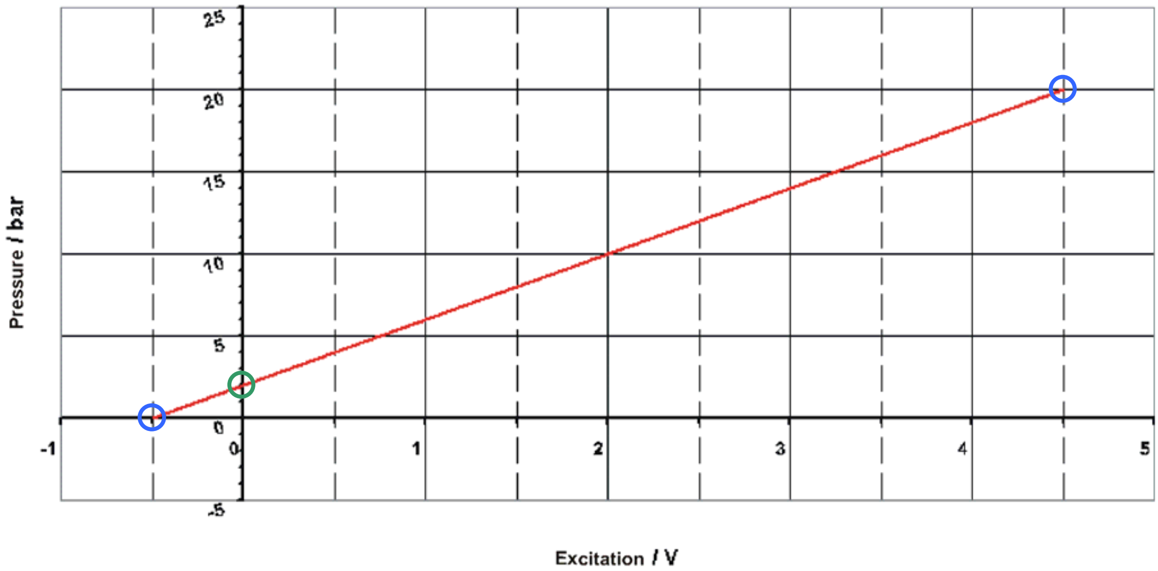
m = dy / dx m = (y1 – y2) / (x1 – x2) m = Slope

Calculation and explanation

1. The linear equation **y = m * x + b** shows the mathematical connection.
2. Calculate the **m** slope within any input range (signal) and the related output range (physical value).
3. Calculate the constant **b** by using the x and y values for a known point.
4. Calculate, if required, further y values by using the corresponding x values and the equation, e.g. for calculating the physical values for another input range (Channel min, max).

Example pressure sensor

A pressure sensor has an output signal of -0.5 to 4.5 V in the acquisition range 0…20 bar.
The voltage signal is converted to the physical value with the linear scaling.

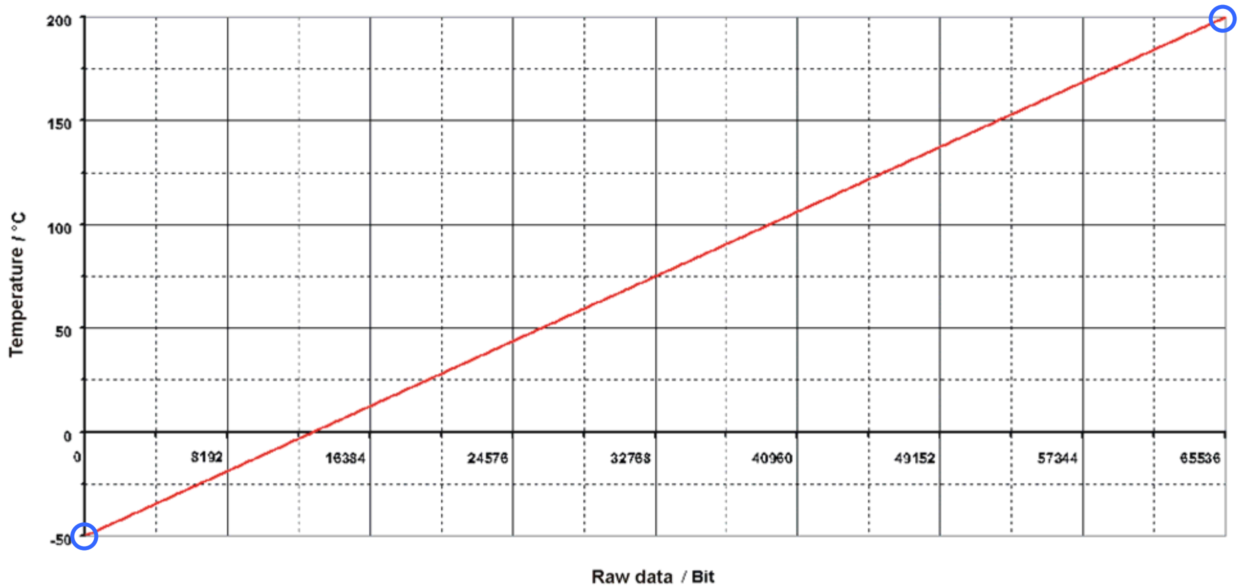


x1	x2	y1	y2	m	b’	b
4.5	-0.5	20	0	4	2	2

Example CAN raw value in the Word unsigned format as temperature

A temperature signal is a CAN message in the Word unsigned format. The value range of 0… 65535 (16 Bit) corresponds to a temperature range of –50 °C… +200 °C.

Please note that the output range has an offset of –50 °C. This must be respected at calculating: (b’ = Offset without output offset, b = Offset + output offset).

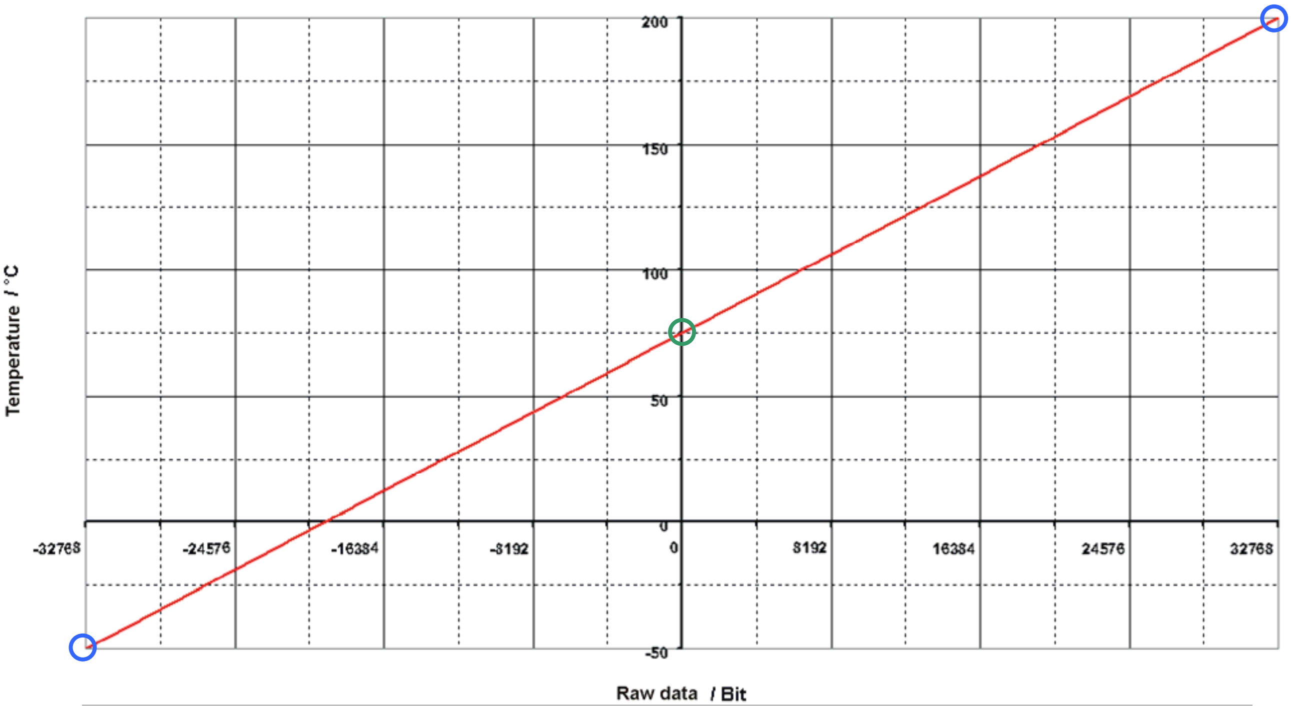


x1	x2	y1	y2	m	b’	b
65535	0	200	-50	0.0038147	0	-50

Example CAN raw value in the Word signed format as temperature

A temperature signal is a CAN message in the Word signed format. The value range of -32768… 0 ... 32767 (16 Bit) corresponds to a temperature range of –50 °C… +200 °C.

Please note that the output range has an offset of –50 °C. This must be respected at calculating: (b' = Offset without output offset, b = Offset + output offset).



x1	x2	y1	y2	m	b'	b
32767	-32768	200	-50	0.0038147	125.0019	75.0019